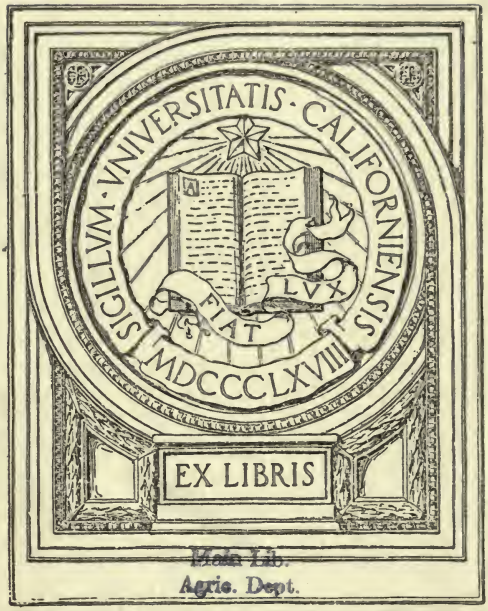

Issued April 12, 1913.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF CHEMISTRY—BULLETIN No. 164.

CARL L. ALSBERG, Chief of Bureau.

GRAHAM FLOUR:

A STUDY OF THE PHYSICAL AND CHEMICAL DIFFERENCES BETWEEN GRAHAM FLOUR AND IMITATION GRAHAM FLOURS.

BY

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1913.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., November 14, 1912.

Sir: I have the honor to submit for your approval a manuscript on "Graham flour," prepared by J. A. Le Clerc and B. R. Jacobs. This manuscript gives the data from the chemical and physical study of many samples of such flour found on the market and in the mills, besides that of samples prepared in the laboratory. The result of this study has a practical bearing on the enforcement of the Food and Drugs Act, inasmuch as it is now perfectly feasible and possible to detect true Graham flour from imitation Graham, made either by the use of a mixture of low-grade products and bran, or by the use of whole wheat meal from which a part of the flour or bran has been abstracted. This study could not have been made without the free and full collaboration of many millers. To them special thanks are due. I recommend the publication of this manuscript as Bulletin No. 164 of the Bureau of Chemistry.

R. E. Doolittle,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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GRAHAM FLOUR.

ORIGIN OF THE TERM "GRAHAM FLOUR."

When wheat was first ground for human consumption the product obtained was an unbolted wheat meal, which was used for bread making for many centuries. In the course of time, however, attempts were made with more or less success to produce a whiter and more attractive product. At first the amount of bran removed was relatively small, consisting only of the coarser particles, but gradually, by improved processes of sifting, more of the bran was removed and the resulting flour was more uniform in appearance and whiter in color. While this flour was still crude as compared with our modern so-called "patent flour" it contained appreciably less ash than the unbolted wheat meal of former times.

According to Sylvester Graham, who lived from 1794 to 1851, the ancients recognized that the bread made from whole-wheat flour was more conducive to general health and vigor and better adapted to nourish and sustain than bread made from superfine flour, and athletes in those times ate the coarse bread only, and he quoted[1] Hippocrates, who is recognized as the father of medicine, as commending bread made from unbolted wheat meal for its salutary effect upon the bowels. Graham, who was a physician and a student of dietetics, recognized from his practice the efficacy of whole-wheat flour in all disorders of the stomach and bowels. He made the claim in his book that he had never known of a case of diarrhea or of costiveness (even though of years standing) to fail to give way after a coarse wheat bread of a proper character had been substituted for that made of superfine flour, although a great number of cases had come under his notice, and that "the thousands of individuals * * * who within the last eight years (about 1830–1838) have been benefited by using the coarse wheaten bread instead of that made of superfine flour, are living witnesses of the virtues of that bread." Graham also quoted Baron Steuben as saying that "the peculiar healthfulness of the Prussian soldiers was in a great measure to be attributed to their ammunition bread made

[1] Science of Human Life, 1839, vol. 2.

of grain, triturated or ground, but not bolted, which was accounted the most wholesome and nutritious part of their rations."

He further quoted from Samuel Prior in regard to the French-English war at the close of the eighteenth century, during which it was shown that owing to the great scarcity of grain due to the small crops in England and to the fact that imports into that country were cut off by the French, Parliament found it necessary and expedient to pass an act (to be in force for two years) that the army at home be supplied with bread made of unbolted wheat meal in order that wheat might go as far as possible and for the better supply of the army on the Continent. Throughout Great Britain the soldiers who were supplied with such bread were at first greatly displeased and refused to eat it, and even threw it away in great rage. However, "after two or three weeks they began to be much pleased with it and preferred it to the fine-flour bread." The result of this experiment was that in a few months the health of the soldiers improved so much as to become a matter of favorable comment on the part of the army surgeons and officers, who "publicly declared that the soldiers were never before so healthy and robust and that diseases of every kind had almost entirely disappeared from the army." Owing to the fact that the newspapers and the civic physicians recommended this bread generally as the "most healthy bread that could be eaten," it became so universally used that in many towns it was almost impossible to find a loaf of fine-flour bread. Subsequently, due to the heavy importation of fine flour from America and to larger crops at home, and to the fact that the act of Parliament was no longer in effect, the people gradually returned to their old habits of eating fine-flour bread.

Graham, who was a noted temperance reformer and lecturer, convinced from his own experience and that of previous ages of the efficacy and value of whole-wheat bread, started about the time his book appeared (1839) a country-wide agitation in favor of a return to the use of bread made with the whole of the wheat, ground but not bolted. He gave specific directions in regard to the treatment of the wheat used for bread making, namely, that it must be plump, mature, and free from rust and other diseases; it must be thoroughly cleansed, not only from chaff, cockles, tares, and such substances, but also from smut and every kind of impurity that may be attached to the skin of the kernel. In other words, the wheat should be washed and cleaned from all impurities, ground by means of sharp stones, coarse rather than fine, inasmuch as the coarse-ground flour makes a bread sweeter and more wholesome.[1] From that time to this unbolted wheat meal has been popularly known as "Graham flour."

[1] Its alleged nutritive or therapeutic advantages over ordinary flour are not considered in this bulletin.

DEFINITIONS OF GRAHAM FLOUR.[1]

Graham flour, according to Circular 19, Office of the Secretary, United States Department of Agriculture, is unbolted wheat meal.

Bulletin 13, part 9, Bureau of Chemistry, United States Department of Agriculture, states that Graham flour is made from well cleaned and dusted wheat, ground but not bolted.

J. M. Hamill, Food Report No. 14 to the Local Government Board of Great Britain, defines Graham flour as follows:

> It is produced by grinding the entire wheat grain. It should therefore contain the same substances in the same proportions as the wheat grain itself. No sieves or bolting cloths are employed in its manufacture, and particles of bran in the flour are obvious. It should contain practically the whole of the germ.

Alfred Romer, chairman of the committee on flour of the New York Produce Exchange, defines Graham flour as—

> wheat meal manufactured from the entire wheat after the wheat has been cleaned. It is usually made from winter wheat milled on burr stones, and contains all the bran, fluff, germ, proteids, fat, and minerals found in the wheat.

Bardet [2] in describing the food value of Graham bread says:

> It contains in totality all the nutritive elements of the wheat.

It thus appears that the statement in Circular 19 that the term "Graham flour" is properly applied only to unbolted wheat meal is supported by the English and French scientific authorities.

CONDITIONS OF THE TRADE.

The condition of affairs in the trade relative to Graham flour seems deplorable. One manufacturer stated that "no part of milling is worse abused than the putting up of so-called Graham flour."

The American Miller, of November 1, 1910, under the heading of "Ambiguous 'Graham,'" states:

> It is a noteworthy fact that in some States millers stand no chance of obtaining contracts for supplying Graham or other whole wheat flours for public institutions. Such contracts very generally go to jobbers, who, one would think, could not possibly supply the goods as cheaply as the miller. Of course there is a reason for this. The Graham and wheat meals furnished to public institutions are often nothing but mixtures—that is, they are not genuine meals, but low-grade flour mixed with bran. The miller, of course, can not compete in price with these mixtures made of mill products, sold from the mill as animal feed and transformed by the mixers into food for those who are charges upon the State. The true Graham is simply a wheat meal, with no part of the wheat removed, except possibly the coarser bran. Yet most of the Graham flour furnished to State institutions is nothing but the mixture described above, which the miller sells as feed and which turns up as food.

A need for an investigation of Graham flour found on the market was quite apparent, and it was therefore deemed advisable to obtain

[1] A glossary of milling and chemical terms used in this bulletin is given on page 57.
[2] J. pharm. chim., 1894, 14: 621.

samples, not only from the ordinary commercial channels, but from the mills. To this end commercial samples as found on the market were collected and a representative of this department, who was both a chemist and an expert miller, visited various mills throughout the country, interviewed the millers, observed the processes of manufacture, and secured samples which were manufactured under his personal supervision. The following information was obtained:

A stated that Graham flour is a product known among manufacturers as resulting from the grinding of white whole wheat, and that the product made from middlings, bran, and bolted flour is not recognized by millers as Graham flour. He acknowledged that a number of merchants are retailing such a mixture under the name of Graham flour, but that this mixed product contains a variable percentage of bran and middlings.

B stated that the term "Graham flour" in his opinion implies a product made by grinding sound, whole wheat, nothing being added or taken out.

C stated that in his opinion Graham flour consists of the whole wheat ground, and that a product made by mixing bran with a bolted flour is not entitled to the name Graham flour.

D stated that his Graham flour is made by running sound No. 2 hard winter wheat once over stone burrs, and is composed of all portions of the wheat berry with nothing added and nothing taken away. He stated further that he has milled Graham flour in this manner for the past 13 years and understands the term "Graham flour" to mean a product produced by simply breaking up the entire wheat berry into a coarse granulation.

E stated that he makes his Graham flour by running sound No. 2 hard winter wheat through four break rolls only, and that no further reductions are necessary. It is composed of the entire wheat berry with nothing added or nothing taken away, and differs from whole-wheat flour only in coarseness of granulation. He stated further that there is an alleged Graham flour which is known among millers as "floor Graham," and which is mixed by them in varying percentages of bolted wheat flour, bran, and shorts, and is marketed as Graham flour. This, he stated, was not in his opinion a true Graham flour, and as it is mixed by the average mill is very unlike a Graham flour milled from whole wheat alone.

F stated that Graham flour is the whole of ground scoured wheat with nothing removed.

G stated that Graham flour is the flour made by grinding whole wheat, removing nothing.

H stated that his Graham flour is the product obtained by running sound No. 2 Nebraska turkey wheat through three sets of corrugated break rolls and that no bran or any other part of the wheat is taken away from this Graham flour, and that no bolted wheat flour or other wheat product is added. He stated that he has milled Graham flour in this manner for six years, during which time he has experimented with the mixing of Graham by putting together different percentages of bolted wheat flour, bran, shorts, red dog, and low-grade flours, but that he has been unable to obtain so satisfactory a product by any combination of the above parts as he obtains by grinding and sacking the entire wheat berry as Graham flour.

I stated that he makes Graham flour out of hard wheat, cleaned and scoured. He runs it through a burr mill, setting the burrs very close together, and makes a very fine product. He does not, however, call it Graham flour but whole-wheat flour. It consists of the whole wheat berry with nothing taken out or added to it.

J stated that his Graham flour is milled by running sound No. 2 hard winter wheat over three sets of corrugated break rolls. After leaving the third roll this product is

sacked as Graham flour. He stated further that he understands a true Graham flour to be a product made by breaking the wheat kernel into moderately fine particles and to consist of the entire wheat berry as milled in its various parts. He stated that the product which is obtained by mixing by hand, or by machinery, various percentages of bran, bolted wheat flour, and other parts of the wheat berry is not a true Graham flour, but is known as "shovel Graham" or "floor Graham" and is manufactured by millers to suit the demands of their trade by supplying them with flour of different grades in color and raising qualities.

K makes an imitation Graham flour by collecting different streams from the different stocks of the mill to make a flour as near as possible to the old-fashioned Graham flour.

L makes an imitation Graham flour from portions of the regular run of wheat flour mixed together by hand.

M makes imitation Graham flour when milling the regular run of flour and it contains nothing except the products taken from the different streams while making flour. He claims to have a process of his own and believes that all other mills operate in about the same manner as he does; that is, by taking different portions of the products of milling and mixing them so as to get the best result.

N makes an imitation Graham flour by blending "exact and known proportions of pure goods."

O makes imitation Graham flour, using chop from the second break, after removing whatever coarse material remains on a 14-mesh wire sieve.

P makes an imitation Graham flour in a burr mill, removing the bran on a 14-mesh wire sieve.

Q makes an imitation Graham flour, using a 21 per cent flour made from two-fifths of winter wheat and three-fifths of spring wheat flour, and to 196 pounds of such flour he adds 70 pounds of bran.

R makes an imitation Graham flour from soft winter wheat and grinds it twice on rolls, removing the coarse material at the first grinding on a 24-mesh sieve, regrinding on a second set of rolls, and removing the remainder on a 10-mesh sieve.

S makes an imitation Graham flour, using 83 parts of an 8 per cent second clear flour and 17 parts of bran. This miller stated that he is obliged to make his flour in this way in order to compete successfully on the market.

T makes an imitation Graham flour from the fifth break obtained in a regular run of white flour. To this material bran is added.

The sample made under the observation of the department's representative showed that the mixture represents about an 8 per cent second clear flour.

U makes an imitation Graham flour by removing the bran at each grinding, taking off altogether about 25 per cent. Some of the middlings are also removed.

V makes an imitation Graham flour from 65 parts of bran and 35 parts of middlings (tailings from middlings) and 200 parts of straight flour. These mill products are mixed with a shovel and then sacked and placed on the market. An inspection revealed the fact that what the miller used and called middlings were really the tailings from the middlings.

W makes an imitation Graham flour from ordinary germ middlings ground down on smooth rolls.

X makes an imitation Graham flour which is a mixture of 40 per cent patent flour, 15 per cent of small bran, shorts and tailings, 45 per cent of low-grade flour. The patent flour used is the 70 per cent patent made from soft winter wheat.

Y makes an imitation Graham flour by using the following products: 66 per cent straight flour, 17 per cent germ middlings, and 17 per cent of bran. This miller said he used the germ middlings because they contain a great deal of the germ and give the flour flavor.

Z makes an imitation Graham flour by mixing several streams of the mill products in the following approximate proportions: 100 parts of straight flour, 100 parts of low-grade, and 70 parts of germ bran. The material is neither weighed nor measured. If the customer wants it rather dark, more low-grade flour is added.

AA makes an imitation Graham flour from soft winter wheat, using three sets of corrugated rolls. He removes all the material that remains on a 20-mesh cotton cloth sieve.

BB makes an imitation Graham flour by mixing by hand low-grade flour, bran, and middling-sizing, which is a tailing from the middlings with the germ. He uses approximately 70 per cent of flour and 30 per cent of bran and middlings, but does not weigh or measure these substances.

CC makes an imitation Graham flour by using a chop from the second break, germ tailings, and purified middlings from the first break that pass through a 56-mesh sieve but stay on a 64. This second break chop represents material that is ground on the second set of corrugated rolls after discarding the portions remaining on a 14-mesh sieve. The purified middlings used are the middlings from which patent flour is produced and represent a high grade of stock in the mill.

DD makes an imitation Graham flour by bolting the ground wheat through a 20-mesh wire sieve and removing the coarse bran. From 12 to 20 per cent of the bran is in this way eliminated.

EE makes an imitation Graham flour by grinding the entire wheat after cleaning and scouring and then mixing it with 50 per cent of straight flour. This imitation Graham flour is therefore made up of 50 per cent of ground wheat and 50 per cent of straight flour, the latter including all the flour produced from the wheat.

FF makes an imitation Graham flour from 20 per cent of bran and 80 per cent of flour, mixed by hand. The bran is a regular feed bran, including shorts, germ middlings, and low-grade flour and the flour is 85 per cent patent.

GG makes an imitation Graham flour from 50 per cent of purified middlings, 48 to 49 per cent of clear flour, and 1 to 2 per cent of bran. These middlings are the stock used for the production of the patent flour; they will go through a 40-mesh cloth and will stay on a 60. The flour used is the second clear produced from the break rolls. The bran is that obtained from the fourth break.

HH makes an imitation Graham flour from a mixture of 75 parts of a 95 per cent grade of bolted wheat flour together with 25 parts of clean bran. These two substances are placed in an agitator and thoroughly mixed for 15 minutes. This miller stated that he mixed his so-called Graham flour in many different ways by putting more or less bolted wheat flour in with clean bran, and that his trade requires that he vary these mixtures, some wanting a higher priced whiter flour with quick-raising qualities, while others of the trade desire a still darker grade, containing more bran and less bolted flour.

II makes his imitation Graham flour by mixing 80 parts of a 25 per cent clear grade flour, 10 parts of clean bran, and 10 parts of germ scalpings. This miller said he was compelled to vary the percentages of the various portions of the wheat kernel in the different batches he made as some of his customers demand a very light product with sufficient bolted wheat flour to make light-colored bread and to have the best raising qualities.

JJ makes his imitation Graham flour by mixing clean bran, fine middlings, and patent flour and stated that it is richer and costs more to manufacture this imitation Graham than to make it from whole wheat. He also stated that frequently low-grade flour is used instead of clear flour.

KK makes his imitation Graham flour by mixing 50 pounds of bran with about 140 pounds of "clear extra fancy" flour. He also stated that his understanding of Graham flour is flour made with bran in it, and that it is often made by grinding the whole wheat.

From these observations it appears that while the millers generally understand by the term "Graham" an unbolted wheat meal, and

while many millers throughout the country are producing Graham flour in this manner, yet in many of the mills an imitation Graham flour is being produced which in the main consists of the by-products of the modern milling and which is generally a mixture of low-grade flour, bran, fiber, offal, and germ, all of which are separations made in the process of milling high and medium grades of flour, and are always eliminated from the high and medium grades.

EXAMINATION OF GRAHAM FLOUR.

Since the passage of the Food and Drugs Act the Bureau of Chemistry has many times been called upon to decide whether certain flours labeled "Graham flour" were or were not true to that name. Little work has been done on the subject and no help is obtained from the literature. In order to secure information in this connection samples of Graham flour were made in the laboratory and samples were collected by a representative of the Bureau of Chemistry from goods manufactured under his direction in various mills throughout the country; samples of the product appearing on the market were also collected.

METHODS OF OBTAINING SAMPLES.

For the purpose of this investigation about 90 samples of Graham and imitation Graham flours were secured. Some of these samples were milled under the observation of the representative of the bureau in order to collect as many data as possible on the processes of milling, the source of the sample, the amount of flour made by the miller, and the manner of disposing of the same. Particular note was made of the manner of milling, the kind of mill used, the number of times the material went through the mill, whether the product was bolted or not, and whether any additions of bran or low-grade flour or abstractions of any portions of the wheat berry were made.

Inasmuch as flour mills do not make Graham flour every day, but only on demand, and this demand limited, many mills visited were found to be making ordinary flour. In most of these cases, however, the miller had samples of the Graham flour from the previous run on hand, and gave information as to the exact manner in which the product was made. Such samples were marked "from stock," with the further designation "true," or "imitation," depending upon the statements of the millers themselves as to the processes of manufacture.

METHODS OF EXAMINING SAMPLES.

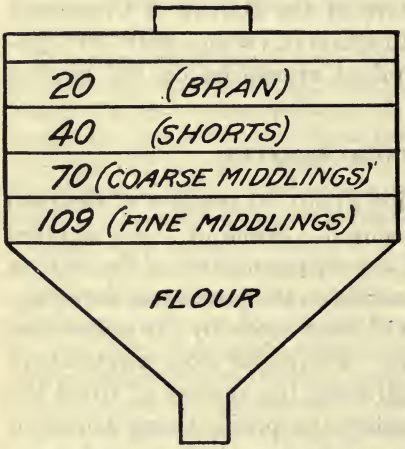
After these samples had been received in the laboratory they were subjected to physical and chemical examinations. The mere chemical analysis of a sample does not always show whether it is an imitation Graham or true Graham because there are greater variations

in the composition of true Graham than are sometimes shown by mixtures of flour with other mill products such as bran or other offal.

PHYSICAL EXAMINATION.

Since Graham flour is supposed to be wheat ground into meal without bolting, it was thought that a mechanical separation of the flour by sifting, and a macroscopic and chemical examination of the several portions would show whether the flour was an imitation or a true product.

Graham flour, when ground either on rolls or on a stone mill, is composed of particles of all sizes, ranging from the chopped bran to impalpable powder, while the general run of imitation Graham flours is composed of bran together with flour which generally is of a very even granulation; therefore all that is necessary to be done in the case of most of the samples of Graham or imitation Graham flour is to pass them through a series of sieves, weigh the portions remaining on each sieve, and make a macroscopic examination of the products. For the purpose of making the mechanical separations, a bolting frame such as is attached to an experimental mill was used. This frame held four sieves (in the case of the first few samples analyzed only three sieves were used, namely, a 20, 30, and 109), giving five separations; that is, those portions remaining on the four sieves and the portion going through the finest sieve. The four sieves used ranged in fineness as follows: 1st, a 20-mesh wire; 2d, a 40-mesh silk bolting cloth; 3d, a 70-mesh silk bolting cloth; 4th, a 109-mesh silk bolting cloth, equivalent to a No. 10 standard silk.



Several preliminary experiments were made to determine the length of time required to have all the material well sifted. It was found that 5 minutes was not long enough, and so 10 minutes was adopted as the proper time to run each sample. All the material that can pass the 109-mesh sieve passes through in 10 minutes at 160 gyrations per minute. This portion is called flour. The accompanying diagram shows a cross section of such a sieve.

A macroscopic examination of the products of separation is of the greatest importance, since in this way one may often detect or determine whether the bran is an added product or not. The appear-

ance of the shorts and the middlings will show the general character of the products used.

Some of the imitation Graham flours found on the market are made from products of the mill which are valuable as flour-producing stock. Such is the case when purified middlings are used, and if these represent any large proportion of the total amount of the imitation Graham, it is quite evident that no attempt is made to dispose of inferior products, since it is more expensive for the miller to grind the wheat and make the separations into offal, middlings, and flour and then mix the resulting products than it would be to grind the wheat on one or two sets of rolls without bolting.

When purified middlings are used in large amounts it is difficult to detect mixtures. Examples of such flours will be indicated in the general discussion of the results (see p. 39).

CHEMICAL METHODS.

Besides making these mechanical separations, the several portions were analyzed for total nitrogen and alcohol-soluble nitrogen, from which results the gliadin ratio was calculated by dividing the alcohol-soluble nitrogen by the total nitrogen. In many cases, also, the ash, fiber, and pentosans were determined in the original sample of Graham flour and in that portion passing through the 109 sieve.

The analysis of each of the samples is given in Tables 1 to 9. In Tables 10, 12, 14, 16, 18, and 20 are found the relative nitrogen content in the flour examined as compared with that in each product of separation and the same relation between the products of separation with one another. In Tables 11, 13, 15, 17, 19, and 21 are found the relative gliadin numbers in the flours examined as compared with those of the products of separation and the same relation between the products of separation with one another.

GENERAL DESCRIPTION OF SAMPLES.

Of the Graham flour samples analyzed, 12 were purchased on the market and designated as true Graham flours. The data obtained are given in Table 2 (p. 17). Seven samples, the analytical data on which are found in Table 3 (p. 17), were also collected by the same representatives of the bureau and are described as imitation Grahams. In Tables 4 and 5 (pp. 17 and 18) will be found the analyses of 12 samples, 6 of them being of the nature of pure Graham and 6 imitation Graham.

Thirteen samples were obtained under observation from the mills and are true to name. The analyses of these will be found in Table 6 (p. 18). Thirteen samples were obtained from "stock" and designated by the millers "true Grahams." Their analyses are to be found in Table 7 (p. 19).

Eight samples were collected under observation, and from the manner of their manufacture are designated "imitation Graham." The results of their analyses will be found in Table 8 (p. 19). Eighteen samples, grouped in Table 9 (p. 20), were obtained from the stock on hand, and according to the description of the method by which they were prepared by the miller they are classified as "imitation Grahams."

Eight samples of Graham flour were made by the use of small experimental mills in the bureau. For this purpose three samples of wheat were ground, namely, a soft winter wheat, a hard winter wheat, and a durum wheat. Two of the samples of wheat were divided into three portions, one portion being ground through the corrugated rolls three times, the second portion through the corrugated rolls five times, and the third portion ground on a burrstone mill. The soft winter wheat was passed through the corrugated rolls only. The analyses of these 8 samples are given in Table 1.

RESULTS OF ANALYSES.

TABLE 1.—*Separation and analysis of Graham flour milled in the Bureau of Chemistry.*

Sample No. and kind.	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Graham flour.				
						Nitrogen.	Ash.	Fiber.	Pentosans.	Gliadin ratio.
Soft winter:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
9904 [1]	24.9	34.4	17.6	8.2	15.0	1.91	1.80	3.01	7.74	38.9
9910 [3]	12.5	16.0	21.7	20.4	28.8	2.03	1.90	3.27	7.74	39.1
Hard winter:										
9922 [1]	9.6	54.8	18.4	7.2	9.5	3.14	1.89	3.17	8.55	42.7
9928 [3]	3.2	31.8	32.5	16.0	16.0	3.16	1.60	2.66	7.21	42.4
9934 [3]	8.0	22.6	15.4	14.2	40.3	3.10	1.78	3.03	7.83	39.7
Durum:										
9940 [1]	25.6	56.4	8.3	4.0	5.6	2.11	1.53	2.76	7.10	35.1
9946 [2]	5.7	53.1	21.9	7.8	10.8	2.11	1.60	2.71	7.84	40.2
9952 [3]	1.3	36.5	30.7	11.8	19.0	2.22	1.59	2.55	7.65	38.2

Sample No. and kind.	Bran.		Shorts.		Coarse middlings.		Fine middlings.		Flour.		
	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Ash.
Soft winter:	*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*
9904 [1]	2.29	30.0	1.91	36.4	1.81	46.1	1.80	48.7	1.63	51.7	0.60
9910 [3]	2.47	26.2	2.38	25.6	1.97	41.0	1.90	44.7	1.74	51.6	.51
Hard winter:											
9922 [1]	3.58	35.2	3.31	39.9	2.75	45.4	2.80	47.1	2.88	50.0	.94
9928 [3]	3.26	33.7	3.53	35.4	2.94	44.6	2.90	48.3	3.07	50.5	.90
9934 [3]	3.23	20.5	3.27	33.9	2.99	38.8	2.98	43.8	2.98	46.8	1.11
Durum:											
9940 [1]	2.30	27.8	2.19	34.5	1.91	39.0	1.88	40.7	1.91	45.9	1.08
9946 [2]	2.30	28.7	2.25	37.2	1.99	42.3	1.91	42.6	1.88	43.3	1.05
9952 [3]	2.12	25.8	2.33	34.6	2.11	40.2	2.12	40.4	2.17	42.3	1.17

[1] Passed through corrugated rolls three times.
[2] Passed through corrugated rolls five times.
[3] Passed through burr mill once.

TABLE 2.—*Separation and analysis of Graham flour purchased on the market.*

Sample No.	On No. 20 sieve, bran.	On No. 30 sieve, shorts.	On No. 109 sieve, middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.		Bran.		Shorts.		Middlings.		Flour.	
					Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*	
6636	0.4	11.8	54.2	33.4	2.47	40.0	2.67	29.2	2.71	26.0	2.40	37.7	2.46	53.6
6637	14.3	8.8	37.6	38.6	2.01	38.7	2.27	21.1	2.62	23.7	1.97	39.5	1.71	53.5
6638	15.5	6.7	31.4	46.0	2.08	36.7	2.58	22.6	2.47	23.0	2.17	34.4	1.81	49.4
6951	5.6	5.9	63.6	24.9	2.01	41.8	2.26	23.2	2.21	25.3	2.01	42.2	2.05	43.4
6952	6.3	7.5	52.4	33.2	1.91	38.9	2.38	20.6	2.36	19.9	1.82	38.5	1.82	50.1
6953	7.3	5.5	57.3	29.8	2.11	39.9	2.44	18.4	2.39	19.9	2.09	37.6	2.02	48.6
6954	12.5	6.0	39.5	42.0	2.01	41.1	2.63	28.5	2.41	24.4	2.01	37.7	1.81	49.7
6955	13.4	5.5	32.0	46.0	1.90	39.8	2.44	27.0	2.47	20.1	1.88	38.4	1.70	49.1
6957	10.0	6.7	29.1	53.4	1.91	39.6	2.49	23.9	2.30	23.1	2.10	32.7	1.68	48.0
6958	16.4	7.0	36.3	40.0	1.94	40.1	2.49	25.1	2.43	21.6	1.95	37.4	1.68	51.7
6959	18.8	4.9	29.7	45.8	1.82	38.1	2.39	26.1	2.47	19.3	1.98	34.7	1.49	46.1
6960	15.2	6.9	42.6	34.6	1.90	40.6	2.36	24.9	2.47	22.7	1.90	39.5	1.60	52.6

TABLE 3.—*Separation and analysis of imitation Graham flours purchased on the market.*

Sample No.	On No. 20 sieve, bran.	On No. 30 sieve, shorts.	On No. 109 sieve, middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.		Bran.		Shorts.		Middlings.		Flour.	
					Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*	
6167	9.1	5.0	7.7	77.8	2.66	39.0	2.68	23.5	2.74	25.6	2.85	22.6	2.66	43.2
6632	14.9	5.5	4.3	74.5	1.99	39.8	2.25	20.5	2.27	21.3	2.31	24.5	1.90	49.0
6633	9.7	6.1	16.7	67.2	2.26	35.0	2.58	21.8	3.16	17.3	2.98	16.9	1.95	49.3
6634	3.2	3.3	6.7	86.3	2.39	44.9	2.95	18.2	3.07	20.5	2.92	21.6	2.26	52.7
6635	16.2	9.3	14.7	59.4	2.15	38.7	2.64	17.3	2.67	18.7	2.07	38.3	1.96	50.8
6639	15.7	8.0	3.9	71.8	2.18	40.5	2.26	19.1	2.35	20.8	2.65	21.4	2.13	50.5
6956	10.7	7.5	12.5	69.2	2.02	41.6	2.36	24.0	2.27	28.4	2.25	32.7	1.90	49.4

TABLE 4.—*Separation and analysis of Graham flour samples.*

Sample No.	On No. 20 sieve, bran.	On No. 30 sieve, shorts.	On No. 109 sieve, middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.		Bran.		Shorts.		Middlings.		Flour.	
					Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*	
6237	13.7	8.7	42.3	35.4	1.69	36.8	2.11	26.5	2.07	25.3	1.70	38.8	1.43	48.6
6238	5.5	13.0	57.2	23.7	1.85	38.8	2.46	28.5	2.54	26.5	1.81	39.9	1.60	55.2
6268	2.9	7.1	49.6	40.1	2.16	37.5	2.61	26.9	2.71	25.6	2.21	35.2	1.89	51.9
6283	11.4	9.1	48.6	29.9	1.99	41.9	2.57	26.2	2.56	24.6	1.95	39.5	1.80	53.7
6500	10.5	5.7	34.0	49.7	1.77	42.0	2.30	25.3	2.27	23.7	1.91	37.1	1.45	58.0
6284	15.1	6.9	20.5	56.5	2.13	36.2	2.61	23.6	2.75	21.4	2.50	32.0	1.79	57.2

TABLE 5.—*Separation and analysis of samples of imitation Graham flour.*

Sample No.	On No. 20 sieve, bran.	On No. 30 sieve, shorts.	On No. 109 sieve, middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.		Bran.		Shorts.		Middlings.		Flour.	
					Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*	
6229	3.9	5.2	21.0	70.0	2.78	40.2	2.30	20.7	2.43	21.9	2.69	22.1	2.83	44.8
6230	6.9	5.8	16.7	70.0	2.68	32.5	2.40	18.4	2.50	19.4	2.78	21.7	2.77	40.2
6231	5.4	5.2	21.3	67.9	2.83	30.7	2.39	18.7	2.54	19.0	2.83	21.8	2.92	37.0
6236	10.2	6.5	9.4	74.1	2.21	34.6	2.43	18.4	2.60	20.5	2.64	18.3	2.10	46.4
6239	4.7	4.0	20.2	71.0	2.11	40.7	2.39	27.4	2.22	27.5	1.93	39.2	2.14	47.5
6269	11.6	3.4	6.6	78.3	2.12	41.7	2.74	24.0	2.72	24.0	2.91	26.5	1.91	52.5

TABLE 6.—*Separation and analysis of Graham flour obtained under observation.*

Sample No.	On No. 20 sieve, bran.	On No. 40 sieve, shorts.	On No. 70 sieve, coarse middlings.	On No. 109 sieve, fine middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.				
						Nitrogen.	Ash.	Fiber.	Pentosans.	Gliadin ratio.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
714	11.4	15.7	12.2	19.8	40.9	2.00	1.94	2.49	6.99	36.2
7728	8.6	18.0	23.0	24.6	24.7	2.07	1.76	2.24	6.70	39.0
7783	4.0	15.4	7.8	15.3	57.8	2.11	1.80	2.39	6.97	38.9
7837	4.6	27.5	29.6	18.8	19.2	2.34	1.83	3.42	7.64	39.6
9049	9.4	16.1	19.1	16.6	38.0	1.74	1.79	1.95	6.68	41.2
9055	7.3	13.4	12.0	17.4	49.9	1.70	1.74	2.36	6.70	40.5
9073	4.0	21.4	18.5	16.6	39.3	2.00	1.87	2.41	7.28	39.7
9091	16.3	20.5	21.4	14.2	27.8	1.73	1.72	2.17	6.70	42.6
9103	5.0	12.5	7.2	14.7	60.6	1.72	1.73	1.87	6.70	41.2
9127	8.8	29.2	23.2	12.2	26.3	1.81	1.71	2.34	6.49	42.7
9145	6.8	11.5	5.7	12.7	62.7	1.60	1.60	2.06	6.47	41.7
9199	5.1	32.7	17.7	10.9	32.8	1.85	1.52	2.36	6.18	41.4
9205	6.5	12.5	8.0	13.5	59.0	1.84	1.69	2.15	6.47	43.1

Sample No.	Bran.		Shorts.		Coarse middlings.		Fine middlings		Flour.		
	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Ash.
	Per ct.		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*
7714	2.66	26.9	2.64	22.3	2.13	33.0	1.91	45.2	1.71	48.4	.....
7728	2.61	24.2	2.66	23.5	1.97	42.4	1.90	52.1	1.71	55.8	0.47
7783	2.64	22.6	2.66	20.8	2.48	23.4	2.07	45.4	1.88	50.4	.65
7837	2.58	25.6	2.56	27.4	2.16	40.3	2.16	44.5	2.33	49.4	.91
9049	2.23	28.3	2.23	24.8	1.65	43.4	1.66	48.2	1.39	52.0	.71
9055	2.25	26.5	2.29	22.7	1.84	35.9	1.62	49.4	1.46	51.4	.68
9073	2.41	27.6	2.60	24.8	2.08	35.4	1.90	47.6	1.71	53.7	.50
9091	2.27	28.5	2.23	27.0	1.57	47.4	1.59	52.1	1.41	53.8	.47
9103	2.36	22.9	2.30	22.9	2.25	25.9	1.71	46.4	1.51	51.6	.67
9127	2.27	28.2	2.06	30.7	1.70	44.6	1.68	51.8	1.57	56.8	.58
9145	2.15	24.2	2.28	20.9	2.16	25.3	1.62	49.0	1.34	54.0	.57
9199	2.44	24.7	2.05	32.9	1.80	44.4	1.76	51.8	1.63	55.1	.53
9205	2.39	22.9	2.42	20.0	2.16	30.2	1.85	46.7	1.67	51.7	.67

TABLE 7.—*Separation and analysis of samples obtained from stocks claimed by millers to be true Graham.*

Sample No.	On No. 20 sieve, bran.	On No. 40 sieve, shorts.	On No. 70 sieve, coarse middlings.	On No. 109 sieve, fine middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.				
						Nitrogen.	Ash.	Fiber.	Pentosans.	Gliadin ratio.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
7707	7.9	12.5	5.0	16.0	57.9	2.17	.....	.....	.....	37.5
7758	10.2	24.0	19.7	16.8	29.0	1.96	1.56	1.99	6.65	38.0
7776	11.9	12.4	15.7	18.5	40.7	2.12	1.75	1.73	6.35	38.4
7789	9.4	14.3	15.1	19.1	42.0	2.11	1.65	1.79	6.55	35.3
7795	13.6	10.1	9.4	20.8	45.5	2.30	.....	.....	.....	37.8
7830	11.8	14.4	16.4	15.7	41.4	2.08	1.73	2.25	7.09	37.8
9061	2.0	13.5	15.8	19.0	49.6	1.74	1.78	2.15	7.00	41.2
9067	9.4	17.2	15.9	14.2	43.2	1.71	1.73	2.24	6.79	39.8
9157	7.8	13.2	15.0	7.5	56.2	1.79	1.36	1.49	5.87	46.2
9163	2.3	6.5	8.6	10.6	71.7	2.47	.95	1.11	5.20	47.4
9193	13.7	12.3	18.5	15.3	39.6	1.88	1.73	1.75	6.57	42.9
9211	3.3	12.5	6.7	7.4	69.4	1.86	1.31	.....	.....	45.3
9223	10.6	21.5	14.6	11.1	41.4	1.82	1.54	2.52	6.92	40.5

Sample No.	Bran.		Shorts.		Coarse middlings.		Fine middlings.		Flour.		
	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Ash.
	Per ct.		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*
7707	2.68	22.5	2.64	21.2	2.65	20.1	2.25	40.2	1.99	48.6	0.73
7758	2.50	28.1	2.34	27.3	1.91	39.0	1.81	50.0	1.63	57.7	.44
7776	2.71	28.4	2.66	25.3	2.11	35.6	1.96	46.5	1.82	50.9	.60
7789	2.80	23.6	2.67	22.6	2.21	29.1	2.00	41.8	1.72	48.2	.59
7795	3.03	28.3	2.93	23.1	2.47	29.8	2.16	45.5	2.02	47.9	.51
7830	2.61	26.6	2.43	24.2	2.02	38.9	2.03	41.5	1.81	47.7	.67
9061	2.04	21.2	2.10	19.0	1.80	34.3	1.72	43.7	1.70	47.5	.89
9067	2.12	25.5	2.30	23.8	1.73	41.4	1.66	48.2	1.43	52.5	.56
9157	2.14	28.5	2.00	27.7	1.58	48.4	1.61	52.1	1.73	55.1	.62
9163	2.53	22.5	2.54	22.1	2.19	40.0	2.23	46.9	2.51	53.0	.76
9193	2.28	28.3	2.44	30.2	1.81	44.6	1.78	53.2	1.73	54.3	.50
9211	2.40	23.7	2.08	25.0	1.93	32.4	1.91	41.9	1.82	53.2	.67
9223	2.26	29.8	2.07	30.3	1.80	42.1	1.82	45.5	1.58	51.5	.65

TABLE 8.—*Separation and analysis of imitation Graham flour obtained under observation.*

Sample No.	On No. 20 sieve, bran.	On No. 40 sieve, shorts.	On No. 70 sieve, coarse middlings.	On No. 109 sieve, fine middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.				
						Nitrogen.	Ash.	Fiber.	Pentosans.	Gliadin ratio.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
7721	3.7	7.5	12.9	30.0	46.0	2.01	1.20	.....	.....	46.8
7803	9.4	12.0	10.3	18.5	49.2	1.97	1.25	.....	.....	38.1
7810	0.0	12.7	14.6	25.0	47.1	1.97	1.20	1.32	5.35	42.0
7818	6.1	14.4	15.0	10.5	53.3	1.88	1.29	1.52	5.71	38.1
9115	3.4	5.5	2.6	5.2	82.4	1.94	1.57	.....	5.85	45.6
9121	14.6	3.8	.6	9.7	71.1	2.41	1.71	.....	.....	46.1
9175	5.3	14.5	4.0	13.4	62.4	2.20	1.37	.....	5.50	43.4
9217	4.3	9.3	9.5	14.8	61.5	2.26	1.72	1.90	6.40	41.3

TABLE 8.—*Separation and analysis of imitation Graham flour obtained under observation*—Continued.

Sample No.	Bran.		Shorts.		Coarse middlings.		Fine middlings.		Flour.			
	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Ash.	Insoluble ash.
	Per ct.		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*	
7721	2.41	20.4	2.64	20.5	1.97	43.0	1.87	51.4	2.05	52.7	0.65	.....
7803	2.82	19.4	2.69	18.5	2.07	41.7	1.99	46.8	1.77	49.5	.43	.....
7810	.....	.....	2.81	21.5	2.08	35.4	1.83	50.6	1.62	52.8	.47	.....
7818	2.41	22.1	2.28	24.0	1.88	36.6	1.87	42.1	1.71	48.0	.65	.....
9115	2.44	22.6	2.33	20.5	2.33	24.1	1.90	44.7	1.95	48.6	1.05	0.03
9121	2.72	25.3	3.17	20.4	2.75	29.5	2.27	44.9	2.36	52.1	.87	.....
9175	3.42	20.5	2.77	23.1	2.26	33.2	2.05	45.2	1.97	53.0	.57	.....
9217	2.39	21.7	2.61	22.6	2.54	27.6	2.40	39.8	2.03	52.5	.84	.....

TABLE 9.—*Separation and analysis of imitation Graham flour obtained from stock.*

Sample No.	On No. 20 sieve, bran.	On No. 40 sieve, shorts.	On No. 70 sieve, coarse middlings.	On No. 109 sieve, fine middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.				
						Nitrogen.	Ash.	Fiber.	Pentosans.	Gliadin ratio.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
7354	1.7	8.3	6.3	27.2	55.2	2.45	1.38	.....	.....	45.3
7734	3.2	24.3	1.7	1.8	68.4	2.02	1.88	.....	.....	41.3
7740	3.6	15.5	6.3	5.7	68.4	2.23	1.88	.....	.....	38.4
7746	5.7	10.9	3.2	3.4	76.8	2.18	1.19	.....	.....	39.3
7752	8.6	18.2	1.9	1.8	69.5	2.30	2.30	.....	.....	41.2
7764	.0	33.0	22.1	17.4	27.4	2.08	1.47	1.70	5.89	40.9
7770	2.5	10.0	1.5	2.2	83.4	2.44	1.80	.....	.....	35.2
7824	9.0	8.4	1.1	1.9	78.7	1.80	1.64	.....	.....	40.6
9079	5.2	8.5	3.5	12.3	69.4	1.74	1.54	2.03	6.61	43.0
9085	2.7	37.2	24.0	12.9	22.9	2.23	.74	.84	3.56	45.3
9097	2.3	20.4	16.8	17.4	42.7	1.70	.79	.69	3.96	45.1
9109	8.6	8.0	1.1	.0	82.3	2.65	2.76	.....	.....	37.3
9139	14.5	17.7	9.6	13.8	44.0	1.82	1.74	2.47	6.85	40.9
9151	.0	21.5	7.3	2.5	68.6	1.96	1.80	.....	.....	38.7
9169	7.6	6.6	.0	.0	85.4	2.32	1.51	.....	.....	47.6
9187	6.7	12.8	7.9	10.3	61.6	1.99	1.46	.....	.....	45.1
9241	10.7	21.0	3.7	10.8	53.6	2.57	1.88	1.97	6.59	39.5
9247	6.0	19.8	7.0	16.2	50.6	1.83	.....	.....	.....	40.3

Sample No.	Bran.		Shorts.		Coarse middlings.		Fine middlings.		Flour.			
	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Ash.	Insoluble ash.
	Per ct.		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*	*Per ct.*
7354	4.13	19.5	3.05	23.2	2.59	26.0	2.27	42.9	2.45	51.4	0.78	.....
7734	2.50	22.4	2.66	23.5	2.57	24.6	2.11	43.9	1.73	56.0	.52	.....
7740	2.66	23.0	2.86	19.6	2.95	13.8	2.39	33.8	2.01	53.7	.57	.....
7746	3.51	18.6	2.93	18.7	2.61	23.9	2.27	39.3	1.97	55.1	.49	.....
7752	2.41	22.7	2.52	21.7	2.43	25.7	2.18	45.0	2.18	51.4	.80	.....
7764	.....	.....	2.37	30.2	1.96	42.0	1.91	45.6	1.71	51.3	.50	.....
7770	2.85	25.1	2.84	21.5	2.75	24.3	2.72	22.7	2.43	37.8	1.25	0.03
7824	2.39	19.5	2.40	20.8	1.91	21.2	1.88	36.6	1.62	50.2	.46	.....
9079	2.13	20.4	2.17	18.4	2.52	18.4	1.80	41.3	1.67	51.3	.57	.....
9085	2.99	26.5	2.08	38.4	2.08	53.4	2.09	55.0	2.08	57.7	.56	.....
9097	2.60	24.6	1.95	31.6	1.70	44.9	1.71	50.2	1.49	57.0	.39	.....
9109	2.22	21.8	2.34	20.4	2.70	20.8	.....	.....	2.70	39.6	1.95	.07
9139	2.25	32.4	2.34	27.9	1.97	32.1	1.71	46.4	1.46	55.8	.50	.....
9151	.....	.....	2.58	19.6	2.76	17.5	2.61	21.5	1.64	57.0	.52	.....
9169	2.26	20.2	2.37	19.2	.....	.....	.....	.....	2.32	53.0	.73	.....
9187	2.30	29.6	2.54	24.9	1.96	38.0	1.78	50.5	1.88	54.0	.58	.....
9241	2.52	33.4	2.42	33.9	2.36	45.6	2.75	32.4	2.58	45.2	1.52	.03
9247	3.72	15.3	2.68	19.4	2.07	26.8	1.67	50.0	1.40	56.1	.39	.....

TABLE 10.—*Nitrogen content ratios of Graham flour and the products of separation.*

Sample No.	Percentage ratio between nitrogen content of—									
	Graham flour and—				Bran and—			Shorts and—		Middlings and flour.
	Bran.	Shorts.	Middlings.	Flour.	Shorts.	Middlings.	Flour.	Middlings.	Flour.	
6636	108	110	97	99	102	90	92	89	91	103
6637	113	130	98	85	115	86	75	75	65	87
6638	124	119	104	87	96	84	70	88	73	83
6951	112	110	100	102	98	89	91	90	93	102
6952	125	124	95	95	99	76	76	77	77	100
6953	116	113	99	96	98	86	83	87	84	97
6954	131	120	100	90	92	76	69	83	75	90
6955	128	130	99	89	101	77	70	76	69	90
6957	130	120	110	88	92	84	67	91	73	80
6958	128	125	100	87	98	78	67	80	69	86
6959	131	136	109	82	103	83	62	80	60	75
6960	124	130	100	84	105	80	68	77	65	84
6237	125	123	100	85	98	81	68	82	70	84
6238	133	137	98	86	103	74	65	71	63	88
6268	121	126	102	87	104	85	73	82	70	85
6283	129	129	98	90	99	76	70	76	70	92
6500	130	128	108	82	99	83	63	84	64	76
6284	123	129	117	84	105	96	69	91	65	72

TABLE 11.—*Gliadin number ratios of Graham flour and the products of separation.*

Sample No.	Percentage ratio between gliadin number of the—									
	Graham flour and—				Bran and—			Shorts and—		Middlings and flour.
	Bran.	Shorts.	Middlings.	Flour.	Shorts.	Middlings.	Flour.	Middlings.	Flour.	
6636	72	65	92	132	90	128	183	142	204	143
6637	55	60	100	137	110	186	252	170	230	136
6638	61	64	94	136	105	155	223	148	213	144
6951	57	62	100	102	109	183	187	168	172	102
6952	53	50	100	132	95	190	250	200	263	133
6953	46	49	95	123	106	206	267	185	240	130
6954	68	59	90	120	86	132	175	154	204	132
6955	68	50	95	123	74	141	181	190	245	129
6957	59	59	82	123	100	139	208	139	203	150
6958	62	51	92	128	84	148	204	176	243	138
6959	68	50	89	121	74	131	177	179	242	135
6960	60	55	97	130	88	156	208	177	236	133
6237	72	69	106	133	96	146	185	152	192	126
6238	72	67	103	144	93	139	196	150	211	141
6268	75	69	95	136	96	134	196	140	204	146
6283	62	57	93	126	92	150	204	163	221	136
6500	59	55	88	138	92	148	232	160	252	157
6284	64	58	89	158	91	135	243	152	271	178

TABLE 12.—*Nitrogen content ratios of imitation Graham flours and the products of separation.*

Sample No.	Percentage ratio between nitrogen content of the—									
	Graham flour and—				Bran and—			Shorts and—		Middlings and flour.
	Bran.	Shorts.	Middlings.	Flour.	Shorts.	Middlings.	Flour.	Middlings.	Flour.	
6167	101	103	107	100	102	106	99	104	97	93
6632	113	114	116	95	101	103	84	102	84	82
6633	114	140	132	86	122	116	76	94	62	65
6634	123	128	122	94	104	101	77	95	74	77
6635	123	124	96	91	99	78	74	77	73	95
6639	104	108	122	98	104	117	94	113	91	80
6956	117	112	111	94	96	95	80	99	84	84
6229	83	87	97	102	106	117	123	111	117	105
6230	89	93	104	103	104	116	115	111	111	99.7
6231	84	90	100	103	106	118	122	111	115	103
6236	110	118	120	95	107	109	86	102	81	80
6239	113	105	91	101	93	81	89	87	96	111
6269	129	128	137	90	99	106	70	107	70	66

TABLE 13.—*Gliadin number ratios of imitation Graham flours and the products of separation.*

Sample No.	Percentage ratio between gliadin number of—									
	Graham flour and—				Bran and—			Shorts and—		Middlings and flour.
	Bran.	Shorts.	Middlings.	Flour.	Shorts.	Middlings.	Flour.	Middlings.	Flour.	
6167	59	64	56	110	109	96	187	88	172	195
6632	52	55	63	125	95	120	245	114	233	200
6633	60	49	49	140	81	76	233	100	288	288
6634	40	45	49	118	111	117	289	105	260	247
6635	44	46	100	131	106	223	294	211	277	132
6639	48	50	50	123	105	110	263	105	250	238
6956	57	67	76	117	117	134	204	114	175	153
6229	50	51	51	110	105	110	220	100	200	200
6230	54	58	67	124	106	117	222	110	210	190
6231	60	63	70	120	106	117	200	116	195	168
6236	51	57	54	134	111	100	235	90	230	255
6239	66	66	95	115	100	144	174	144	174	121
6269	57	57	62	124	100	108	216	108	216	200

TABLE 14.—*Nitrogen content ratios of Graham flour obtained under observation and the products of separation.*

Sample No.	Percentage ratio between nitrogen content of—													
	Graham flour and—					Bran and—				Shorts and—			Coarse middlings and—		Fine middlings and flour.
	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Coarse middlings.	Fine middlings.	Flour.	Fine middlings.	Flour.	
7714....	133	132	106	96	86	99	80	72	64	81	73	65	90	80	89
7728....	126	128	95	92	83	102	75	73	65	74	71	64	97	87	90
7783....	125	126	118	98	89	101	94	79	71	93	78	71	83	76	91
7837....	110	109	92	92	99	99	83	83	90	84	84	91	100	108	108
9049....	128	128	95	96	80	100	74	75	63	74	75	62	100	84	84
9055....	132	135	108	95	86	102	82	72	65	80	70	63	88	79	90
9073....	121	130	104	95	85	108	86	79	71	78	71	63	91	82	90
9091....	131	129	91	92	81	98	69	70	62	71	72	64	101	90	89
9103....	137	134	131	99	88	97	95	72	64	98	75	67	76	67	88
9127....	131	119	99	98	92	91	75	74	69	84	83	79	99	92	93
9145....	134	143	135	101	84	106	100	75	63	95	70	59	75	62	82
9199....	132	111	97	95	88	84	74	72	67	90	89	83	98	91	93
9205....	130	131	117	100	91	100	90	78	70	90	76	69	85	77	90

TABLE 15.—*Gliadin number ratios of Graham flour obtained under observation and the products of separation.*

Sample No.	Percentage ratio between gliadin number of—														
	Graham flour and—					Bran and—				Shorts and—			Coarse middlings and—		Fine middlings and flour.
	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Coarse middlings.	Fine middlings.	Flour.	Fine middlings.	Flour.	
7714....	73	61	92	103	133	85	127	173	185	150	204	218	136	146	117
7728....	62	59	108	130	140	96	175	216	229	183	226	239	124	131	106
7783....	58	53	58	116	129	91	105	204	227	115	225	250	196	217	111
7837....	65	69	101	112	125	107	158	174	193	147	162	180	110	122	111
9049....	68	59	105	117	127	86	153	171	186	179	200	216	112	121	108
9055....	65	55	87	123	128	85	135	188	196	159	222	232	140	146	104
9073....	69	62	90	121	136	89	130	174	190	146	196	221	134	151	113
9103....	54	54	61	112	124	100	114	209	232	113	209	232	184	204	111
9127....	67	71	105	121	133	107	157	182	200	146	170	187	116	127	110
9145....	59	49	61	120	132	83	104	204	225	125	245	270	196	216	110
9191....	67	64	112	124	126	96	168	186	189	174	193	196	111	113	102
9199....	59	78	107	124	134	133	183	212	229	138	160	172	116	125	108
9205....	50	47	70	101	119	91	136	209	232	150	230	255	132	142	111

TABLE 16.—*Nitrogen content ratios of alleged Graham flour obtained from stock and the products of separation.*

Sample No.	Percentage ratio between nitrogen content of—													
	Graham flour and—					Bran and—				Shorts and—			Coarse middlings and—		Fine middlings and flour.
	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Coarse middlings.	Fine middlings.	Flour.	Fine middlings.	Flour.	
7707....	123	121	122	104	92	99	99	84	74	100	85	75	85	75	88
7758....	127	119	98	93	83	94	77	72	65	82	77	70	95	85	90
7776....	128	125	99	93	86	98	78	73	67	79	74	68	93	86	93
7789....	132	126	105	95	82	95	79	71	61	83	75	64	90	78	86
7795....	131	127	107	94	88	97	82	73	67	84	74	69	87	82	94
7830....	125	117	97	98	87	94	78	78	69	83	84	75	105	90	89
9061....	117	121	103	99	98	103	88	84	83	86	82	81	96	94	99
9067....	124	134	101	97	84	108	82	78	67	75	72	64	96	83	86
9157 [1]...	120	112	98	90	103	93	74	75	81	81	82	88	102	109	108
9163 [1]...	102	103	89	91	102	100	86	88	99	86	88	99	102	115	113
9181....	139	129	104	104	67	93	75	75	48	80	80	52	100	65	65
9193....	121	130	96	95	92	107	79	78	76	74	73	71	98	96	97
9211 [1]...	129	112	104	103	98	87	81	80	76	93	92	88	99	95	95
9223....	124	114	99	100	87	92	80	81	70	87	88	76	101	88	87

[1] So-called whole wheat flour or bolted wheat meal.

TABLE 17.—*Gliadin number ratios of alleged Graham flour obtained from stock and the products of separation.*

Sample No.	Percentage ratio between gliadin number of—														
	Graham flour and—					Bran and—				Shorts and—			Coarse middlings and—		Fine middlings and flour.
	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Coarse middlings.	Fine middlings.	Flour.	Fine middlings.	Flour.	
7707....	59	57	54	108	130	95	90	182	218	95	190	228	200	240	120
7758....	74	71	103	132	150	96	139	179	204	144	185	211	128	146	114
7776....	74	66	92	121	132	90	125	164	179	140	184	200	131	143	109
7789....	66	60	83	117	137	96	126	178	209	127	186	218	141	166	117
7795....	73	59	76	119	124	82	104	161	169	126	196	204	155	162	104
7830....	68	62	100	108	124	92	146	158	180	158	171	198	108	123	115
9061....	51	46	83	105	115	90	162	205	224	179	226	247	127	138	109
9067....	64	59	105	123	133	92	164	192	208	178	209	226	117	127	108
9157 [1]...	61	59	104	113	119	96	171	186	196	178	195	204	108	115	106
9163 [1]...	47	47	85	98	113	100	182	209	241	182	209	241	115	132	115
9181....	89	82	93	126	134	91	100	115	150	110	126	165	115	150	131
9193....	67	71	105	126	129	107	157	189	193	147	177	180	121	123	102
9211 [1]...	50	56	70	98	116	108	138	176	226	128	164	212	128	166	129
9223....	72	75	105	113	128	104	145	156	176	140	150	170	107	121	119

[1] So-called whole wheat flour or bolted wheat meal.

TABLE 18.—*Nitrogen content ratios of imitation Graham flours obtained under observation and the products of separation.*

Sample No.	Percentage ratio between nitrogen content of—														
	Graham flour and—					Bran and—				Shorts and—			Coarse middlings and—		Fine middlings and flour.
	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Coarse middlings.	Fine middlings.	Flour.	Fine middlings.	Flour.	
7721	120	131	98	93	102	110	82	78	85	75	71	78	95	104	110
7803	143	137	105	101	90	95	74	71	63	77	74	66	96	86	89
7810	.....	143	106	93	81	.....	.....	.....	.....	74	61	58	88	78	89
7818	128	121	100	99	91	95	78	78	71	82	82	75	99	91	91
9115	126	120	120	99	100	95	95	78	80	100	82	84	82	84	103
9121	112	131	113	94	98	117	101	83	87	87	72	75	82	86	104
9175	155	126	102	94	92	81	66	60	58	82	74	71	91	87	96
9217	106	115	112	106	90	109	106	100	85	97	92	78	95	80	85

TABLE 19.—*Gliadin number ratios of imitation Graham flours obtained under observation and the products of separation.*

Sample No.	Percentage ratio between gliadin number of—														
	Graham flour and—					Bran and—				Shorts and—			Coarse middlings and—		Fine middlings and flour.
	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Coarse middlings.	Fine middlings.	Flour.	Fine middlings.	Flour.	
7721	43	43	93	111	113	100	215	255	260	215	255	260	119	121	151
7803	50	48	108	118	128	95	216	237	258	228	250	272	110	120	109
7810	.....	50	83	119	176	.....	.....	.....	.....	167	238	247	143	149	104
7818	58	63	95	111	126	110	164	191	218	150	175	200	117	133	114
9115	49	44	53	98	107	110	110	200	218	120	220	240	183	200	109
9121	54	43	63	96	113	80	116	176	208	145	220	260	152	179	118
9175	46	53	77	105	123	115	165	225	265	144	196	230	136	161	118
9217	51	54	66	95	127	105	127	186	247	123	177	236	144	193	133

TABLE 20.—*Nitrogen content ratios of imitation Graham flours obtained from stock and the products of separation.*

Sample No.	Percentage ratio between nitrogen content of—														
	Graham flour and—					Bran and—				Shorts and—			Coarse middlings and—		Fine middlings and flour.
	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Coarse middlings.	Fine middlings.	Flour.	Fine middlings.	Flour.	
7354	168	124	106	93	100	74	63	55	60	85	74	80	88	95	108
7734	124	132	127	104	86	106	103	84	69	97	80	65	82	68	82
7740	120	128	132	107	90	108	111	90	76	103	84	70	81	68	84
7746	161	134	120	104	90	84	74	65	56	89	77	67	87	76	87
7752	105	110	106	95	95	105	101	90	90	97	87	87	90	90	100
7764	.....	115	94	92	82	.....	.....	.....	.....	83	81	72	97	87	89
7770	117	116	113	111	99	100	97	95	83	97	96	86	99	89	89
7824	133	133	106	104	90	100	80	79	68	80	78	68	99	85	86
9079	122	125	144	103	96	102	118	85	79	116	83	77	62	56	93
9085	134	93	93	94	93	70	70	70	70	100	101	100	101	100	100
9097	150	111	98	98	85	75	66	66	58	87	88	76	100	92	85
9109	84	89	102	.....	102	105	122	.....	122	115	.....	115	.....	100	.....
9139	123	128	108	94	80	104	88	76	65	84	73	62	87	74	85
9151	.....	131	140	133	84	.....	.....	.....	.....	107	101	64	95	60	63
9169	97	102	.....	.....	100	105	.....	.....	102	.....	.....	98	.....	.....	.....
9187	116	128	99	90	94	110	85	77	82	77	70	74	91	96	106
9241	98	94	92	107	100	96	94	109	102	98	114	106	117	109	94
9247	203	146	113	91	77	72	56	45	38	77	62	52	81	68	84

TABLE 21.—*Gliadin number ratios of imitation Graham flours obtained from stock and the products of separation.*

Sample No.	Percentage ratio between gliadin number of—														
	Graham flour and—					Bran and—				Shorts and—			Coarse middlings and—		Fine middlings and flour.
	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Coarse middlings.	Fine middlings.	Flour.	Fine middlings.	Flour.	
7354	42	51	58	93	113	121	137	222	269	113	182	221	162	196	121
7734	54	57	59	105	137	122	109	195	254	104	187	243	179	233	130
7740	60	50	34	87	140	83	57	143	230	69	174	279	254	408	166
7746	46	46	59	100	141	118	128	216	305	128	216	305	170	239	141
7752	54	51	61	110	124	95	114	205	232	119	214	243	180	204	113
7764	.....	72	103	110	125	.....	.....	.....	.....	140	150	170	107	121	113
7770	71	60	69	63	106	84	96	88	148	114	105	176	92	154	168
7824	48	50	51	90	120	89	111	189	263	100	175	265	171	238	139
9079	47	42	42	95	119	90	90	205	255	100	228	283	228	283	124
9085	58	84	118	122	127	146	204	211	219	140	145	150	104	107	104
9097	54	69	98	111	127	129	183	208	237	142	161	184	114	130	135
9109	57	54	54	.....	105	95	100	.....	186	100	.....	195	.....	195	.....
9139	80	67	80	115	137	84	100	144	172	119	170	204	144	172	120
9151	.....	50	.....	55	150	.....	.....	.....	.....	.....	111	300	.....	.....	271
9169	43	40	.....	.....	111	95	.....	.....	262	.....	.....	276	.....	.....	.....
9187	64	53	84	111	120	83	131	172	186	158	208	225	132	142	180
9241	85	85	115	82	115	100	136	97	136	136	97	136	71	100	141
9247	38	48	65	125	140	127	173	333	373	137	263	295	192	215	130

DISCUSSION OF RESULTS OF ANALYSES.

SAMPLES GROUND IN THE BUREAU OF CHEMISTRY (TABLE 1).

Table 1 shows that when the sample of soft winter wheat is ground five times between the corrugated rolls, a greater amount of middlings and flour is obtained and a less amount of bran and shorts than when it is passed only three times over the rolls. The nitrogen,[1] ash, fiber, and pentosan content and the gliadin ratio of the Graham flour produced are essentially the same in both samples. It is seen, however, that No. 9904 has a higher gliadin ratio of the bran, shorts, and middlings than No. 9910. This is because these products of the coarsely ground Graham flour have adhering to them a larger amount of flour than when the Graham flour has been more finely ground. Another point of interest is that there is a gradual decrease in nitrogen content and a gradual increase in gliadin number from the bran to the flour.

In the case of the hard winter wheat and durum wheat Grahams, it is noted that the nitrogen content of the flour is about equal to or greater than that of the fine, or even of the coarse, middlings. This fact leads one to infer that in the process of grinding hard wheats a relatively large amount of break flour is produced. Break flour from hard wheats is often higher in nitrogen than is the bran.[2]

Samples 9922 and 9928 contain normal amounts of ash, fiber, and pentosans. The gliadin ratio gradually increases from the bran to the flour. On the other hand the nitrogen content of the middlings is lower than that of the flour. The amount of flour passing through the 109 sieve is extremely low, being only 9.5 and 16 per cent, respectively, whereas in the case of soft winter wheat the corresponding amount was 15 and 28.8 per cent. No. 9934, which was ground on burrstones, shows a larger amount of flour material (40.3 per cent) than the samples ground by means of corrugated rolls. The nitrogen, ash, fiber, and pentosans agree fairly well with the two samples passed through the rolls. The gliadin ratio of the bran especially is much lower than that of the bran from Nos. 9922 and 9928, due to the fact that the bran of No. 9934 contained less flour and middlings. The gliadin ratio of the other portions separated is also lower than the corresponding portions of the two samples ground on rolls, probably because these contained more particles of bran which had been finely ground between the burrs. For the same reason (namely, high bran content) the percentage of ash is higher in the flour from No. 9934.

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[1] The nitrogen determinations were all made in the Nitrogen Laboratory, T. C. Trescot, chief.

[2] Analyses made of bran and of flour from wheat milled in this bureau showed that the nitrogen of the flour is sometimes 1 per cent more than that of the bran.

Nos. 9940, 9946, and 9952 are made from durum wheat. The amount of combined bran and shorts is greatest in No. 9940 and least in No. 9952, the former having been passed three times through the corrugated rolls and the latter having been ground between burrs. The amount of flour is least in No. 9940 and greatest in No. 9952 and so are the middlings. The nitrogen, ash, fiber, pentosans, and gliadin ratio in all three samples agree quite well. As in the case of hard winter wheat, the nitrogen of the flour passing through the 109 sieve in each case is equal to or greater than that of the fine middlings. In No. 9952 the nitrogen of the flour is even greater than the nitrogen of the bran. In each case the gliadin ratio increases from the bran to the flour.

The amount of middlings in No. 9940 is only 12.3, yet the fact that the shorts are so high (56.4 per cent) indicates that a large proportion of the middlings and flour particles are adhering to them. A small amount of middlings considered by itself is not necessarily an indication that the flour is not genuine.

Comparing all three sets of Graham flour produced from the three varieties of wheat it is seen that the ash of the flour from the soft winter wheat passing the 109 sieve is the lowest, and that from durum wheat is highest. Yet the ash of the Graham flour from the soft winter wheat is higher than that from the durum. This is explained by assuming that in the process of grinding soft wheat there is a more complete separation than when hard wheat is ground. In the latter case the particles of bran are more easily broken up and they find their way into the middlings and into the flour.

SAMPLES OF TRUE AND IMITATION GRAHAM FLOURS (TABLES 2, 3, 4, AND 5) PURCHASED ON THE MARKET.

The samples in Tables 2 and 3 will next be described and the results discussed. These 19 samples, as has already been stated, were bought on the market. Twelve samples are true Graham flours, while seven of them are imitation Graham flours, one of which was labeled "Graham flour style." These samples, as well as those reported in Tables 4 and 5, to be discussed later, were subjected to a physical separation on sieves Nos. 20, 30, and 109, No. 70 not being used. The material on the No. 20 sieve was called bran, that on the No. 30 shorts, and that on the No. 109 middlings, there being no distinction made between the coarse and fine middlings as was done with the other samples. The material going through the 109 sieve was called flour.

Table 2 shows the variations in the percentage of these various constituents in each sample, and likewise the percentage of nitrogen and the gliadin number of the Graham flour and of each portion separated. The bran content is seen to vary from 0.4 to 18.8 per

cent, the shorts from 4.9 to 11.8. These differences are due, of course, to the thoroughness or fineness of grinding. In the same way the amount of middlings will show a variation, the table showing that the percentage varies from 29.1 to 63.6, while the flour which passes through the 109 sieve shows a variation of from 24.9 to 53.4 per cent. In no case does the amount of flour which passes through the 109 sieve exceed 55 per cent. Generally in samples of true Graham flours the percentage of nitrogen is greatest in the bran and very slightly less in the shorts, while it is considerably less in the middlings and still less in the flour passing through the 109 sieve, so there is a gradual gradation in the amount of nitrogen from bran to flour. In every case the percentage of nitrogen in the flour of the samples in Table 2 is less than that found in the bran or shorts, whereas the contrary very often happens in the case of imitation Graham flours, as will be seen in Table 5.

The low amount of bran found on the No. 20 sieve, especially in Nos. 6636, 6951, 6952, and 6953, is probably due to the fact that the wheat from which these samples were milled was of the hard winter variety. As a general rule Graham flour is made from soft winter wheats, in which case the amount of bran is likely to be greater on account of the fact that it is not so finely ground in the process of milling.

In looking over the gliadin ratio of the various products separated by the sieves it is seen that there is a gradual increase from bran to flour. The bran and shorts, however, are very much alike. They contain practically the same amount of nitrogen and the same amount of alcohol-soluble nitrogen, thus giving almost identical gliadin ratios. The middlings, however, show a much higher gliadin ratio. Generally the higher the gliadin ratio of the middlings the less bran is found therein; in other words, the purer the middlings are. The same statement applies to the flour passing the 109 sieve. If we assume that the gliadin ratio of the middlings is 100 the average of that of the flour passing the 109 sieve is about 140. (See Table 11, p. 21.)

Considering these samples as a whole neither the data on the physical separation nor the nitrogen and gliadin ratio of the flour passing the 109 sieve would indicate that they were anything but true Graham flour, except possibly the low amount of bran and shorts found in four of the samples.

In sample No. 6951 the amount of flour passing the 109 sieve is relatively small. The fact that hard winter wheat was used in the preparation of this sample might lead one to expect that break flour would form a large part of this product. The consequence is that the percentage of nitrogen in this product is about the same as the percentage of nitrogen in the middlings obtained from the same flour, while the gliadin number of this product is the lowest of the 12

samples in this table. Break flours, of course, contain a much lower percentage of gliadin than straight flours or patent flours.

No. 6636 shows a very small amount of bran, due to the fact that the material has been repeatedly passed through the corrugated rolls. This sample was also made from hard wheat and it is much easier to break up the bran of hard wheat into finer particles than in the case of soft wheat. The remaining samples of Table 2 are quite uniform, both as to the percentage of nitrogen and as to the gliadin ratio in the various products. In no case is it found that the nitrogen of the flour or of the middlings is higher than that of the shorts.

Commercial samples of imitation Graham flours were analyzed in the same manner and these results are found in Table 3.

No. 6167 was labeled "Graham flour style," thus indicating that it does not pretend to be a true Graham flour. The results of the analysis show that it contains over 77 per cent of flour passing the 109 sieve, a much larger amount than was found in any of the samples of true Graham flours already discussed. Another characteristic factor is seen in comparing the amount of nitrogen in the various products of separation, the nitrogen of the middlings being higher than the nitrogen of the shorts and the bran. The amount of middlings is also very small and so is the gliadin number, thus indicating that the flour was made up practically of bran and ordinary flour.

No. 6632 is made from 75 parts of a 95 per cent flour and 25 parts of cleaned bran. This is thoroughly mixed in an agitator and sacked for the trade. The miller stated that he varied the amount of bran added according to the demands of the trade, a darker flour containing more bran and less flour. This sample contains over 74 per cent of material passing the 109 sieve. Here again the percentage of nitrogen in the middlings is higher than that found in the bran and the shorts. The gliadin ratio of the middlings is very low, much lower in fact than the gliadin ratio of the middlings from any of the Graham flours in Table 2.

No. 6633 is supposed to be made from a mixture of 80 parts of a 25 per cent clear grade flour, 10 parts of cleaned bran, and 10 parts of germ scalpings. The miller claimed that he did not use shorts, red dog, or low-grade flour. This sample contains 67 per cent of material passing through the 109 sieve. The percentage of nitrogen in the middlings is much higher than that found in the bran. The gliadin number of the middlings is very low, being the lowest of the seven samples given in this table. It is also lower in the middlings than in any of the products of separation of this sample. The gliadin number of the original Graham flour is likewise the lowest of the seven samples. The high percentage of nitrogen in the bran and shorts and middlings is in accordance with the statement that germ scalpings had been used.

No. 6634 consists of a mixture of one-third of fine shorts and germ stock and one-fourth of cleaned bran, the remainder being clear flour. This sample contains a much smaller amount of bran and shorts than would be found if 25 per cent of the sample had been made up of clean bran, unless, of course, the bran had been so finely ground as to become mixed with the middlings. The small amount of this material, however, shows that while the middlings may contain some bran, the amount therein is so small that one must conclude that the miller did not use so much bran and shorts as he claimed, and that this sample was made, therefore, mostly by mixing a relatively small portion of offal with ordinary flour. Eighty-six per cent of this sample passed the 109 sieve. Here again we find a very low gliadin number in the middlings and at the same time the middlings nitrogen is about equal to that found in the bran. This shows that the middlings are composed of a very inferior product.

No. 6635 is made by mixing 25 per cent of clean bran, 15 per cent of fine middlings, 55 per cent of patent flour, and 5 per cent of germ stock. In this case only 59 per cent was found to pass the 109 sieve. From the analysis it is apparent that the sample is made from good stock. The miller stated that it cost more to make this flour than it did to mill Graham flour direct from the wheat.

No. 6639 is typical of the imitation Graham flours, as put out by most firms, and consists of 25 per cent of bran and 75 per cent of clear flour. It is made from hard winter wheat. The separation shows that the product has been made by the mixture of bran and flour, for it contains nearly 72 per cent of material passing the 109 sieve and less than 4 per cent of middlings. Furthermore, the percentage of nitrogen in the middlings is much higher than that in the bran and shorts, showing the middlings to be of a very poor quality. The gliadin ratio of the middlings is very low, which is also proof of the inferior quality of this product.

No. 6956 is supposed to have been made from one-fifth bran and four-fifths of first-class flour. The amount of material passing the 109 sieve is 69 per cent, while the amount of middlings is 12.5 per cent. The gliadin ratio of the sample itself is high, as is also that of the middlings and likewise of the flour passing through the 109 sieve. The fact that it contains so much material passing through the 109 sieve is the only feature which would lead one to suspect that it is not true Graham flour. Taking the samples in Table 3 as a whole, five of the seven show as high a nitrogen content in the middlings as is found in the bran; while in Table 2, which gives the analysis of true Graham flours, no single sample shows the nitrogen content of middlings to be greater than that of bran; likewise the gliadin number of the middlings of the samples of imitation Graham flour in Table 3 is very much lower than the corresponding gliadin numbers

from the true Graham flours as reported in Table 2, with one exception, namely, No. 6635, where it has been shown that patent flour was used in making the imitation Graham.

From these tables it is seen that the gliadin ratio of the bran and shorts from true Graham flour is, as a general rule, higher than the gliadin ratio of the same products obtained from the imitation Graham flours; especially is this so when the latter are made by the admixture of clean bran and shorts with flour of various grades.

Tables 4 and 5 contain the results of analysis of ordinary Graham flours collected at another time. From the description of the method of their manufacture and from the mechanical separation and the chemical analysis they are classified as true and imitation Graham flours, respectively. In Table 4 each of the six samples contains the normal amount of bran and shorts excepting No. 6268. The amount of bran and shorts in this sample is abnormally low. This can be explained if the wheat from which the flour was milled was a hard wheat, as a large portion of the bran would then be so finely ground as to pass through the No. 30 sieve. None of these samples has an amount of flour passing the No. 109 sieve exceeding 57 per cent. The nitrogen and the gliadin ratio of each product in the separation are normal, the nitrogen of the flour being somewhat lower than that of the middlings, and in turn the nitrogen of the middlings being lower than that of the shorts and bran. This applies to every one of these samples. The gliadin ratio of the middlings is in every case above 32 per cent, showing that this product is of comparatively good quality.

In Table 5 are found the samples of imitation Graham flours. In every one of these samples the amount of bran and shorts is much lower than would be normally found in Graham flour, except possibly in Nos. 6236 and 6269. In those cases, however, since the percentage of middlings is only 9.4 and 6.6, respectively, it is evident that only a small portion of the bran and shorts could have been so finely ground as to pass the No. 30 sieve, and therefore it is justifiable to assume that the samples in question are made up of ordinary flour and a small amount of offal. In each of the six samples the amount of flour passing through the No. 109 sieve is over 67 per cent, while in Table 4, containing the samples of true Graham flour, the highest amount of that material is 56.5 per cent.

In considering these two tables as a whole it is seen that the gliadin numbers of the products of separation of the true Graham flour are somewhat higher than those of the imitation Graham flours. This is true not only of the bran and shorts, but particularly in the case of the middlings, with the possible exception of sample No. 6239, which sample has a gliadin ratio equal to that of true Graham flour middlings. This sample is an imitation flour, notwithstanding the high gliadin ratio of the middlings, because of the fact that it contains

such a small amount of bran, shorts, and middlings, and such a large amount of flour passing through the 109 sieve and also because the nitrogen of this latter product is greater than the middlings nitrogen. The gliadin numbers of these products vary considerably, depending upon the method of milling the wheat. This is due to the fact that when a Graham is made, the wheat is simply run over corrugated rolls or between stone burrs in such a way as to reduce the wheat without, however, producing absolutely clean bran, shorts, or even clean middlings. The bran and shorts almost invariably contain a considerable amount of flour and hence the gliadin number is higher than in the corresponding products of imitation Graham flour in which clean bran, shorts, and low-grade flour are mixed together. The gliadin number of the flour passing through the 109 sieve, obtained from Graham flour, is as a rule higher than that obtained from imitation Graham flours, this being due to the fact that the latter are generally made from mixtures of low-grade flours and bran while Graham flour contains the whole kernel of the wheat and hence a larger proportion of good material. It has been found that the gliadin number of a product increases with the quality of that product; that is to say, the highest patent flour made from any particular variety of wheat would have the highest gliadin number; therefore, when alleged Graham flours give a product which passes the 109 sieve and have an abnormally low gliadin number it is justifiable to assume that low-grade flour has been used. No. 6167 of Table 3 and Nos. 6229, 6230, and 6231 of Table 5 are types of this kind of flour.

Samples Nos. 6229 to 6231 show another characteristic often found in imitation Graham flours; that is, the percentage of nitrogen in the flour passing through the 109 sieve is greater than that of any of the other products and even of the original imitation Graham flour. In these samples the nitrogen of the flour is also greater than the nitrogen of the bran. Occasionally this is also the case with true Graham flour, but only when the amount which passes through the 109 sieve is very small, indicating that the latter is of the nature of a break flour; this generally occurs when the Graham flour is made from a hard spring wheat. In these samples the high amount of flour clearly indicates that it is not a question of break flour but that a low-grade product has been used in making the alleged Graham flour. All these samples in Table 5, except No. 6239, show the middlings nitrogen to be greater than the bran nitrogen. This may be due to the fact that in most cases the middlings are tailings from middlings which are generally very high in nitrogen.

Tables 10 and 11 (p. 21) show the relative amount of nitrogen and the gliadin number, respectively, of the Graham flour and each product of separation from Graham flour. Tables 12 and 13 give the same relation with regard to imitation Graham flours. These tables

show how much more regular the samples of Graham flour are than the samples of imitation Graham, in the following respects:

The bran and shorts obtained from Graham flour are invariably higher in nitrogen content than the Graham flour itself. This is not always the case with imitation Graham flours. In Graham flour the middlings generally contain somewhat less nitrogen than does the Graham flour itself. In imitation Graham the amount of nitrogen in the middlings very often exceeds to a considerable extent that found in the original sample. The flours passing through the 109 sieve obtained from Graham flour are all with one exception lower in nitrogen than the original flour itself. This exception is No. 6951, which contains a very small amount of this product, and that being practically of the nature of a break flour, inasmuch as the wheat which had been used for making the Graham flour was hard wheat. The middlings obtained from Graham flour contained from 74 to 96 per cent as much nitrogen as is found in the bran from the same Graham. While with imitation Graham flours the amount of nitrogen in the middlings varies from 78 to 118 per cent as much as is found in the bran, in the majority of cases the percentage of nitrogen in the middlings in the imitation Graham is higher than that of the bran and shorts. The middlings of the true Grahams, however, contain less nitrogen than do the shorts or bran.

Tables 12 and 13 on page 22 bring out more prominently the differences in the gliadin ratios of the middlings from both Graham and imitation Graham flours, showing that as a general rule the middlings from Graham flour have a much higher gliadin ratio relative to the bran than do the middlings from the imitation Graham flours. The same relation exists when the gliadin ratio of the middlings is compared with that of the shorts.

GRAHAM FLOUR SAMPLES.

Table 6 contains the analysis of the Graham flour obtained under observation from the mills, and also the analysis of the products of separation. Besides giving the amount of nitrogen and the gliadin number of the original Graham flour and the products of separation, this table also contains the ash, fiber, and pentosans found in the original Graham flour, and likewise the ash content of the product passing through the 109 sieve.

Tables 7, 8, and 9 (pp. 19 and 20) contain the same relative data of the supposed Graham flour obtained from stock at the mills, of the imitation Graham flours obtained under observation, and of the imitation Graham flours obtained from stock in the mills, respectively. These additional data will help materially to distinguish between true and imitation Graham flours. This is sometimes impossible from the mere separations on the sieves or from the

nitrogen content of the products. In these tables, and likewise in all subsequent ones, the separations of the samples represented therein were made on four sets of sieves, that portion remaining on No. 20 being called the bran, on No. 40 shorts, on No. 70 coarse middlings, on No. 109 fine middlings, and through No. 109 flour.

Samples obtained under observation (*Table 6*).—No. 7714 is made on a burrstone mill.

No. 7728 is ground on three sets of corrugated rolls without bolting, the wheat having been moistened with 1½ pints of water to every 4 bushels of wheat, in order to make the bran more flaky.

No. 7783 is made from soft winter wheat without moistening and ground on a French burr mill. This sample contains a very small amount of bran and likewise a very small amount of coarse middlings. The gliadin ratio of the coarse middlings is the lowest of all the samples in this table. The macroscopic examination of the coarse middlings showed that the product of separation contained a large amount of bran, which would of course increase the nitrogen content and therefore lower the gliadin ratio. The use of a burr mill has a tendency to give a more finely ground product, which would explain the presence of bran (finely ground) in the middlings and also the large amount of flour passing the 109 sieve.

No. 7837 is made from hard spring wheat and contains a very small amount of bran. The gliadin ratio of the fine middlings is lower than that of any of the other samples of the Graham flour, and the gliadin ratio of the flour passing through the 109 sieve is the lowest but one. The amount of material which passes through this sieve is likewise low, the lowest found among the samples recorded in the table, indicating that a large proportion of it may be of the nature of a break flour, due to the fact that the wheat used was a hard spring wheat. The percentage of nitrogen in the flour is higher than the percentage of nitrogen in the middlings. The ash content of this product is much higher than that of any of the other samples, which fact, taken in connection with the high nitrogen content and with the low amount of material passing through the 109 sieve, goes to show that this product was to a large extent a break flour and is what one might expect when a hard spring wheat is made by the ordinary process into Graham flour.

Nos. 9049, 9055, and 9103 are from the same miller and all from hard spring wheat. The first was ground as for the ordinary trade, the second medium ground, and the third as finely ground as possible without injuring the product. No. 9103 contains a very small amount of bran and of coarse middlings and over 60 per cent of material passed through the 109 sieve. The gliadin ratio of the coarse middlings of this sample is low, due to the fact that a considerable portion

of bran had been ground fine enough to pass the 40 sieve. This was evident from a macroscopic examination of the product.

Nos. 9073 and 9091 are made by passing the wheat through two sets of rolls, No. 9127 by passing the wheat through three sets of rolls.

No. 9145 is made from soft winter wheat by grinding very fine on burr stones. This sample contains a very small amount of bran and coarse middlings and the largest amount of flour passing through the 109 sieve of any sample here recorded. The gliadin ratio of the coarse middlings is low, due to the amount of bran found in that product of separation.

No. 9199 is made from soft winter wheat on one set of steel rolls. After going through the rolls the coarse material is scalped off on a 50-mesh cloth and run over another set, which chops up the bran. The two streams are run together, blended and sacked. The whole kernel of the wheat is used in this process.

No. 9205 is made from soft winter wheat ground on a French burr mill. This sample contains a relatively low gliadin number in the coarse middlings, due to the fact that these coarse middlings contain a large amount of bran, as shown by a macroscopic examination.

From these samples it is seen that as a rule the use of burr stones yields Graham flour with small amounts of bran and coarse middlings, and a very large amount of flour. The gliadin ratio of the coarse middlings is very low, due to the presence of bran particles.

The amount of bran and shorts combined was in no case less in these samples of Graham flour (in Table 6) than 17.5. The highest amount was 38.0. The amount of coarse middlings on the 70 sieve varies from 5.7 per cent to 29.6, while the fine middlings vary from 10.9 to 24.6 per cent. The amount of combined middlings varies from 18.4 to 48.4 per cent. As a general rule, the percentage of flour passing through the 109 sieve is less than 60, although two samples show an amount slightly above that figure, namely, 9103 and 9145.

As was previously stated, wherever the bran or shorts are from an extraneous source and are clean, the gliadin ratios of these products are very likely to be relatively low, and vice versa. From this table it is noted that wherever the bran is high in amount, which means it contains more or less flour adhering to the particles, the gliadin ratio of that sample of bran is relatively high. The same holds true with the shorts. If these shorts contain any considerable amount of middlings the gliadin number will be much higher than if the shorts are clean and practically free from adhering flour.

The percentages of ash, fiber, and pentosans in each of the samples are normal and what might be found in ordinary samples of wheat. The gliadin ratios of the bran and shorts indicate that in every case they are of good quality; that is, they contain more or less substance of a higher nature, as middlings or flour, adhering to them. The

gliadin ratios of the coarse middlings show a great difference, varying from 23.4 to 47.4. It is seen that wherever the percentage of coarse middlings is low the tendency is for the gliadin ratio to be low also. This is because the sample has been more finely ground than usual, the bran going to some extent through the finer sieves and the middlings passing with the flour. The percentage of gliadin in the fine middlings is quite uniform, varying from 44.5 to 52.1. Likewise, the gliadin ratio of the flour shows that each of the samples in Table 6 is of good quality, the variation being 48.4 to 56.8 per cent.

Regarding the percentage of nitrogen in the flour passing through the 109 sieve, in no case has it been found to exceed that found in the bran or in the shorts. This is a good indication that the flour is Graham flour, though not necessarily a proof of that fact; but as has been seen in case of imitation Graham flours it very often happens that the nitrogen content of that portion passing through the 109 sieve is higher than the nitrogen content of the bran or shorts of the same sample.

The percentage of ash in that portion of the Graham flour passing through the 109 sieve varied from 0.47 to 0.91.

Samples obtained from stock (*Table 7*).—Table 7 gives the results obtained from Graham flour secured from stock and described by the miller as true to type. The method of milling these samples was not, however, observed by the representative of the bureau.

No. 7707 is supposed to have been ground on a burrstone mill. This sample has an abnormally low gliadin content in the coarse middlings, due to the fact that the amount of this product is very low and contains a relatively large percentage of bran. The gliadin ratio of the fine middlings is also low. This is no doubt a sample of imitation Graham.

No. 7758 is ground on three stands of corrugated rolls. The product is normal in every respect and shows it to have been produced from good stock. Even the ash content, which is low, is above the minimum found in true Graham flour.

No. 7776 is ground once on a burrstone mill. This sample is also normal both as to the separation on the sieves and as to the chemical analysis.

No. 7789 has been ground on three stands of corrugated rolls. The coarse middlings contain a small amount of bran, otherwise it is normal.

No. 7795 is ground on a burrstone mill and shows no abnormality.

No. 7830 is normal in every respect.

No. 9061 is ground on a burrstone mill where the burrs were set very close together, thus making a very fine product. This sample was called whole-wheat flour by the miller, because he considered that the term "Graham" had become meaningless and had fallen into

disrepute. It is, however, what is known as Graham flour, inasmuch as nothing has been removed from or added to the wheat. It contains only 2 per cent of bran, due to its having been so finely ground.

No. 9067 is ground on three sets of corrugated rolls placed over each other. It is a good quality "Graham."

No. 9157 is ground on burrstones, the manufacturer calling this sample "wheat meal." It is made from a very white Michigan wheat, resembling in some respects white Australian. It contains a relatively small amount of ash, fiber, and pentosans, indicating that some of the bran has been removed. It also has a very high gliadin ratio. Only one other sample shows such a high gliadin ratio, namely, No. 9163, and this one is more of the nature of a wheat meal than of Graham flour.

No. 9163 is made from spring wheat. This sample contains only 2.3 per cent of bran, 6.5 per cent of shorts, 19.2 per cent of combined middlings, and over 71 per cent of flour. It likewise contains 0.95 per cent of ash, all of which shows that this is not a sample of Graham flour, but is what is improperly called whole-wheat flour or "bolted wheat meal." This is shown, not only from the percentage of ash, but also from the percentage of fiber and pentosans in the original sample, indicating that a considerable amount of bran must have been removed in the process of milling. This sample, however, was stated by the miller to be Graham flour and sold by him as such.

No. 9193 is made from soft winter wheat by running it over 5 sets of corrugated rolls, and 12 sets of smooth rolls, in the same manner as wheat flour is treated. This was bolted, and afterwards the material was mixed together again. This sample was called whole-wheat flour, and it does not differ from true Graham made by simply grinding wheat without bolting. The amount of labor in grinding it so many times over the corrugated and smooth rolls and then mixing the products is all unnecessary, and tends to make a more expensive but not necessarily a better product.

No. 9211 was ground on an attrition mill with iron disks run in opposite directions. Soft winter wheat was used in the making of this flour. Both the coarse and the fine middlings were more or less contaminated with bran particles, due probably to the fact that the sample had been ground very fine. The amount of flour passing through the 109 sieve is much higher than would normally occur in Graham flour, but this is explained from the fact that the material was much finer ground than usual. The amount of ash in the original sample is only 1.3 per cent. Inasmuch as the amount of bran, shorts, and combined middlings is relatively small it would seem that a certain portion of bran had been removed in the preparation of this sample.

No. 9223 is made on burrstones. The product is normal in every respect.

In only one of these samples does the percentage of nitrogen in that product passing the 109 sieve even approximate the percentage of nitrogen found in the bran and shorts of the same sample. This is No. 9163, which, as already stated, is a sample of wheat meal and not Graham.

The bran content varied from 2.0 to 13.7, the shorts from 6.5 to 24.0, the combined bran and shorts from 8.8 to 34.2, the coarse middlings from 5.0 to 19.7, the fine middlings from 7.4 to 20.8, the combined middlings from 14.1 to 36.5, the flour from 29.0 to 71.7. Thus it is noted that the samples milled under observation proved more regular than those from stock. The variations in the ash, fiber, and pentosan contents are far greater also among these samples than in the samples of true Graham flour obtained under observation. This is no doubt due to the fact that among the samples obtained from stock there are two which are ordinary wheat meal, but which were designated as Graham flour by the miller. If these two samples be eliminated, the variations are not greater than were found in the case of Table 6 containing Graham flour samples.

IMITATION GRAHAM FLOUR SAMPLES.

Samples obtained under observation (Table 8).—Table 8 contains the results of analysis of imitation Graham flours obtained under observation. The method of the manufacture of these samples and a discussion of the results follow:

No. 7721 is supposed to have been made by mixing 50 per cent of purified middlings, 48 to 49 per cent of clear flour, and 1 to 2 per cent of bran. The middlings are the stock used in producing patent flour. They passed a 40-mesh cloth, but remained on No. 70. The flour is the second clear from the breaks. The bran is that obtained from the fourth break. The miller claimed that never more than 3 per cent of bran is used, and they only mix in that much when customers want very coarse Graham; but inasmuch as no measuring or weighing of these products was made it is difficult to tell just how the miller knows how much of each of these products he is using. The separation of the sample shows that the miller was guessing as to the amounts used. In this sample the percentage of bran and shorts combined amount to 11.2, an abnormally low amount to be found in a Graham flour, but a much higher amount than the miller claimed to have used. The percentage of ash is also much lower than normal, being 1.2. These two facts go to show that a considerable amount of bran must have been removed from the wheat in the production of this sample, which is in agreement with the miller's statements.

The percentage of nitrogen in the flour passing through the 109 sieve is higher than the percentage of nitrogen in either the coarse or the fine middlings, due no doubt to the fact that clear flour was used in the preparation of this sample, which has a higher nitrogen content than the purified middlings, which also were used.

No. 7803 is made from the chop from the second break together with germ tailings and middlings, the latter being obtained from the first break and fine enough to pass through a 56 mesh but remaining on a 64. The second break chop represents the material that is ground on a second set of corrugated rolls after having been sifted through a 14-mesh wire sieve. The middlings used in this case are those from which patent flour is produced and represent the high-grade stock. The figures obtained in the separation on the sieves are normal. The amount of ash in the original sample, however, is too low, showing that the sample contains a less amount of bran than would normally be found in Graham flour.

No. 7810 is made on a three-stand set of rolls, everything remaining on a 20-mesh wire sieve being removed and only the material passing through being used in the production of this flour. In this way from 12 to 20 per cent of the wheat is eliminated as bran. This sample shows no bran at all and only about 12 per cent of shorts, indicating that the product has been scalped to a considerable extent. The ash content is only 1.2 per cent, another indication that the bran has been removed. The same thing is indicated from the low fiber and the low pentosan content.

No. 7818 is made on a three-stand set of corrugated rolls, the ground wheat being mixed with an equal amount of straight flour. The straight flour used for this mixture represents all of the flour produced by the mill. The ash, fiber, and pentosan contents of the original flour all indicate that this flour contains a much smaller amount of bran than would be found in a normal Graham flour.

No. 9115 is made from the soft winter wheat milled on a burrstone. Low-grade flour is added without, however, measuring the amount, the millers claiming that they use about 75 per cent of wheat and 25 per cent of low-grade flour. The millers gave two reasons why their flour is made in this way: First, it makes a whiter product; and, second, it reduces the cost. The products of separation show a very small amount of bran, shorts, and middlings and 82 per cent of flour passing through the 109 sieve. This would seem to show that the miller sometimes added more than 25 per cent of low-grade flour. The ash content of the material passing through the 109 sieve is extremely high, namely 1.05 per cent, showing that a large proportion of low-grade flour must have been added in the making of this product. All in all, the results of the analysis of this sample show that it is a mixture of low-grade flour with a very small amount of offal of the

mills. The gliadin ratio of the coarse middlings is very low. A macroscopic examination of this product shows it to contain a considerable amount of bran.

No. 9121 is made from the flour of the fifth break obtained in the regular run of milling white flour. To this product bran is added. The flour used represents about an 8 per cent second clear. The results of the separation on the sieves show that the flour must have been made from a mixture of flour with bran, because only 0.6 per cent of coarse middlings was found in the sample and less than 10 per cent of fine middlings. The sample shows approximately the normal amount of bran and shorts, and about the proper amount of ash, but the ash content of the flour passing through the 109 sieve, namely 0.87 of 1 per cent, indicates more or less a low-grade product.

No. 9175 is made by mixing several products while in the process of making ordinary flour, namely, the fifth and sixth middlings before reduction, the first, fourth, and fifth break flours, and the flour from germ middlings. The miller, however, does not know in what amounts these are mixed, as he neither weighs nor measures them. He depends upon the appearance of the resulting product. The percentage of ash and pentosans in the original sample indicates that some of the bran has been eliminated in the preparation of this flour.

No. 9217 is a mixture of 40 per cent patent flour, 15 per cent small bran, shorts, and tailings, and 45 per cent of low-grade flour. The patent flour used is a 70 per cent patent made from a soft winter wheat. One to two per cent of the coarse bran is taken off. The amount of bran is somewhat low, otherwise the sample analyzed similar to normal Graham flour with the possible exception that the ash content of the material passing through the 109 sieve is a little above the average for a soft winter-wheat flour. This amount of ash, namely, 0.84 per cent, is about equal to that obtained from a mixture of patent flour and a low-grade flour.

The percentage of bran or material left on No. 20 sieve varies from 0 to 14.6, of shorts on No. 40 sieve from 3.8 to 14.5, of combined bran and shorts from 8.9 to 21.4. The coarse middlings showed a variation of 0.6 to 15.0, while the fine middlings varied from 5.2 to 30 per cent. The combined middlings varied from 7.8 to 42.9. The amount of flour passing the 109 sieve varied from 46.0 to 82.4, half of the samples yielding over 60 per cent of this product. The percentages of ash, fiber, and pentosans averaged, as a rule, lower than those of the same constituents in Graham flour. In fact the ash of these samples is so low as to lead to the conclusion that most of them are more of the nature of so-called wheat meal than of imitation Graham flours. Of 63 samples of soft wheats analyzed for ash,

the average was 2.10, varying from 1.57 to 2.68 per cent. Of 43 samples analyzed for fiber, the average amount found was 2.40, the highest being 3.33, the lowest 1.99. It is evident therefore that at least five of these eight samples in Table 8 had a considerable amount of bran removed and thus are not entitled to the name "Graham flour." As a whole these samples of imitation Graham flour obtained under observation are much better and showed much greater uniformity with regard to the high quality of products used than were found in Table 5, or than will be found in Table 9, which gives the analysis of imitation Graham flour obtained from stock on hand.

Samples obtained from stock (Table 9).—No. 7354 is made from tailings of the fourth and fifth middlings, the first, fourth, and fifth break flour, and germ bran, which is also called germ middlings and which is a mixture of shorts, germ tailings from middlings, and low-grade flour. This sample shows low bran and shorts content, likewise a low amount of coarse middlings. The percentage of ash is also lower than would be found in a normal Graham flour. The high percentage of nitrogen in the bran is noticeable, which gives a correspondingly low gliadin number. This is no doubt due to the fact that a large amount of germ bran has been used. This sample gives a rather low gliadin ratio in the coarse middlings. The high percentage of nitrogen and ash in the flour passing through the 109 sieve (the nitrogen being higher in fact than that of the fine middlings) indicates that low-grade flour had been used to a greater or less extent.

No. 7734 has been made by mixing the mill products by hand, namely, 70 per cent of straight flour, 20 per cent of germ middlings or germ bran, and 10 per cent of bran. The straight grade of flour used represents 94 per cent of the total flour produced from the wheat. This sample contains 3.5 per cent of combined middlings, 68 per cent of the material passing through the 109 sieve. These two factors indicate at once that the material is an imitation Graham flour. Thus far no sample of Graham flour has been found containing so low an amount of middlings. The gliadin ratio of the coarse middlings is very low, indicating that this product is not only small in amount, but that it is more or less contaminated with bran particles. The ash content of the flour passing through the 109 sieve shows that a straight flour has been used in the preparation of this sample.

No. 7740 is made by mixing 66 per cent of straight flour, 17 of germ middlings, and 17 of bran. The miller uses the germ middlings, because the large amount of germ therein gives the flour flavor. The straight flour used includes all the flour made from the wheat. The extremely low gliadin ratio of the coarse middlings and the relatively low gliadin ratio of the fine middlings can be explained from the fact that the miller here uses in the production of this flour a large amount

of germ middlings. This sample contains a larger percentage of nitrogen in the coarse middlings than it does in the bran or shorts, due of course to the high nitrogen content of the germ middlings. The ash content of the flour passing through the 109 sieve indicates the use of a straight grade of flour.

No. 7746 is made by mixing several streams of the mill products in the following approximate proportions: 100 parts of straight flour, 100 parts of low-grade and 70 parts of germ bran, the coarse bran being scalped off. The germ bran, also known as germ middlings, is a mixture of shorts and germ tailings from the middlings and low-grade flour. This material is neither weighed nor measured. If a customer wants it rather dark, more low-grade flour is added. In examining the separations one notices at a glance the relatively low amount of combined middlings and of bran and the high amount of material passing through the 109 sieve. The percentage of ash is extremely low, namely, 1.19, so low in fact as to indicate that a large proportion of the bran had been removed in the production of this flour. The high percentage of nitrogen in the bran is in accordance with the statement that germ bran had been used. This applies likewise to the relatively high percentage of nitrogen in the shorts. The gliadin ratio of the coarse middlings is also low, indicating that a portion of the bran and germ have gone through the 40 sieve.

No. 7752 is flour obtained from a baker who had purchased it in barrel lots from the same miller who milled 7721, already described in Table 8, which was obtained under observation, the miller stating that all of this flour was sold to the retailers in small packages. An attempt, however, to obtain a sample of this flour from the retailers was unsuccessful.

A comparison of the two samples shows that when the miller delivered to the representative of the bureau flour which had been milled under observation he took care to make and deliver a first-class product, but that this differed materially from the product sold to the trade. It is seen at a glance that this sample (No. 7752) was made from a mixture of bran and clear flour, because the percentage of combined coarse and fine middlings is only 3.7, while the percentage of flour passing through the 109 sieve is over 69 per cent, showing that such a product could not have been made as reported, namely, by the use of 50 per cent of purified middlings, 48 to 49 per cent of clear flour, and 1 to 2 per cent of bran, as No. 7721 is supposed to have been made. The amount of bran and shorts in this sample is 26.8 per cent, while in 7721 it is only 11.2. While the percentage of combined middlings in this sample is 3.7, in No. 7721 it is 42.9, thus showing two entirely different kinds of imitation Graham flour, the first one (No. 7721) being a sample of imitation Graham made from good stock, the second one (No. 7752) being the regular product of the

mill as sold to the ordinary trade. The percentage of ash in the product passing through the 109 sieve is 0.80, indicating a clear flour.

No. 7764 is made from soft winter wheat ground on three sets of corrugated rolls, all the material remaining on the 20-mesh cotton cloth sieve being rejected. It is evident from the analysis that this is a sample of so-called whole-wheat flour, there being absolutely no bran on the 20 sieve. The percentage of ash, which is 1.47, and the percentage of fiber and pentosans, which are also low, indicate the absence of a considerable portion of the bran.

No. 7770 is made by mixing by hand low-grade flour, bran, and middling sizing, which is tailings from the middlings with the germ. The miller said he used 70 per cent of flour and 30 per cent of bran and middlings, but this material was neither measured nor weighed. The sample contains 2.5 per cent of bran, 3.7 per cent of combined middlings, and over 83 per cent of material passing through the 109 sieve. The ash content is normal, but the gliadin ratios of the coarse and fine middlings are both very low. A macroscopic examination of these products showed them to contain much bran. The ash content of the material passing through the 109 sieve is 1.25, indicating the use of a low-grade flour.

No. 7824 is made by mixing by hand 20 per cent of bran and 80 per cent of flour. The bran is a regular feed bran which includes shorts, germ middlings, and low-grade flour. The flour is an 85 per cent patent; 17.4 per cent of combined bran and shorts are found, 3 per cent of combined middlings and almost 79 per cent of material passing through the 109 sieve. This corroborates very closely the statement by the miller as to the manner of making the sample. The gliadin ratio of the coarse middlings is low and an examination of this product shows it to be contaminated with particles of bran.

No. 9079 is made on a burrstone mill, all the material on No. 14 mesh being removed. In this way from 8 to 10 per cent of the wheat is eliminated as bran. This statement is more or less confirmed by the mechanical separations on the sieves, the results of which show only 5.2 per cent of bran, 8.5 per cent of shorts, and 3.5 per cent of coarse middlings. The low gliadin number of the coarse middlings is due to the fact that this product is contaminated with a portion of the bran which has been finely ground. The appearance of this product is very poor.

No. 9085 is supposed to have been made by using the chop from the second break after removing the coarse material on a 14-mesh wire sieve. The ash content of this sample is 0.74 per cent, indicating that this sample is more of the nature of an improperly called whole-wheat flour than it is of a Graham flour. It is characterized by an extremely high gliadin ratio of the shorts, coarse middlings, and fine middlings, due no doubt to the manner of its manufacture, namely,

that the chop from the second break only had been used, thus eliminating to a large extent the low-class products. The percentages of fiber and pentosans in the original sample are in accordance with the percentage of ash and indicate the removal of most of the bran in the preparation of the flours.

No. 9097 is made from soft winter wheat on a 4-set stand of corrugated rolls. The bran is scalped off after each grinding, removing about 25 per cent altogether. Some of the middlings are also removed. This imitation Graham flour is really made from the unreduced product that makes up a cut-straight. The analysis shows only 2.3 per cent of bran. The small amounts of ash, fiber, and pentosans indicate that only a small part of the bran had been allowed to remain in the sample. The gliadin ratios of the shorts and coarse and fine middlings are very high. This is due to the fact that so much of the coarser particles which tend to give low gliadin ratios had been removed. It has been shown in an early discussion that the more bran particles that are present in these products the lower is the gliadin ratio, and vice versa.

No. 9109 is made by mixing 83 parts of an 8 per cent clear flour and 17 parts of bran, the dealer claiming that this imitation Graham is thus made in order to compete with the commercial—that is, imitation—Grahams on the market. For the purpose of making this imitation Graham both the bran and the clear flour are bought separately. The separation shows 16.6 per cent of combined bran and shorts, only 1.1 per cent of combined middlings, the rest, or over 82 per cent, passing through the 109 sieve. The analysis practically corroborates therefore the method of preparation, as stated by the dealer. Several peculiarities are apparent in examining the result of analysis of this sample. First, there is a high percentage of ash in the sample and also in that part passing through the 109 sieve, showing that the latter is due to the low-grade quality of the flour used. Another peculiarity is that the percentage of nitrogen in the flour passing through the 109 sieve is far higher than that of the bran and shorts. In such case, where the bran and the clear flour are bought separately, it may very easily happen that the bran may have been obtained by the milling of one kind of wheat and a clear flour by the milling of another kind. This sample may therefore be said to be characteristic of an imitation Graham flour as made by the jobber. The gliadin ratio of the coarse middlings is very low, and an examination of this product shows it to contain a large proportion of branny particles.

No. 9139 is made from soft winter wheat ground on steel rolls, some of the bran being scalped. Both the separation and the analysis of the sample indicate that only a small amount of the bran could have been removed in the process of preparing this product, for we find 14.5 per cent of bran, 17.7 per cent of shorts, and the ash content is

1.74 per cent, all of which indicate a normal sample. The gliadin ratio of the bran is high, indicating that a considerable proportion of the endosperm was still adhering to the bran particles.

No. 9151 is supposed to have been made by mixing 59 parts of coarse bran, remaining on a 12-mesh sieve, 38 parts of coarse middlings free from flour or shorts, 3 parts of white middlings free from red dog, and 50 parts of straight flour, the last being made from soft winter wheat. The analysis shows an entire absence of bran, and only 9.8 per cent of middlings, there being 68.6 per cent of material passing through the 109 sieve. The low gliadin ratio of the coarse middlings and of the fine middlings are explained by the presence of a relatively large amount of bran particles therein. The entire absence of bran disproves the miller's claim that he added coarse bran to the sample.

No. 9169 is reputed by the miller to have been made from a mixture of a 21 per cent clear flour obtained from two-fifths of winter wheat and three-fifths of spring-wheat flour. To each 196 pounds of this clear flour 70 pounds of bran are added. The mechanical separation shows 14.2 per cent of bran and shorts and 85.4 per cent of flour passing through the 109 sieve, but an entire lack of middlings.

No. 9187 is claimed by the miller to have been made from a soft winter wheat ground twice on rolls, scalping at the first grinding over a 24-mesh sieve and regrinding on a second set of rolls and scalping the material on a 10-mesh sieve, removing in this way about 5 per cent of the total wheat in the form of the coarser bran. The ash content of this product is 1.46 per cent, indicating that some bran had been removed in the process of milling; otherwise the sample is normal and indicates a good product throughout.

No. 9241 was forwarded to the laboratory as an imitation Graham, without, however, giving a description of the method of preparation. There is nothing in the results of the mechanical separation to indicate that it might not be Graham flour. The percentage of ash in the sample is likewise normal, so are the percentages of fiber and pentosans. The gliadin ratios of the bran, shorts, and coarse middlings would seem to indicate that these products contain more or less of the higher class products adhering to them. The percentage of nitrogen in the fine middlings is appreciably higher than the percentage of nitrogen in the bran, shorts, and coarse middlings, showing possibly that tailings from middlings were here used. The percentage of ash in the flour passing through the 109 sieve is very high, which, taken in connection with the high amount of nitrogen in that product, and also in the fine middlings, would indicate that the fine middlings and flour were more or less of the nature of a low-grade

product. The chemical analysis of the products of separation would therefore quite properly place the sample among the imitation Graham flours.

Regarding No. 9247 no information is at hand. From the mechanical separation alone this sample might also be a Graham flour. A very high nitrogen content of the bran and of the shorts and the correspondingly low gliadin ratios of these products would seem to indicate that this sample contained a certain amount of added germ. The low gliadin ratio of the coarse middlings leads to the same conclusion.

The samples of imitation Graham flour found in stock, but whose method of manufacture was not observed, show greater differences than have been noted in either the Graham flours or even in the imitation Graham flours collected under observation. The bran varied from 0 to 14.5, the shorts from 6.6 to 37.2, the coarse middlings from 0.0 to 24.0, the fine middlings from 0 to 27.2, and the flour from 22.9 to 83.4 per cent, the combined bran and shorts from 10 to 39.9, the combined middlings from 0.0 to 39.5 per cent. These samples also show a greater irregularity in chemical composition tha do even the imitation Graham samples collected under observation. The nitrogen content of the original sample varies from 2.22 to 4.13, the high percentage being due to the presence of germ in the bran. This accounts for the varying and low gliadin ratio found in these samples. The same applies to the shorts. The ash content of the product passing through the 109 sieve likewise varies greatly—namely, from 0.39 to 1.95 per cent, the use of low-grade flour tending to give a high ash content. Where a high ash was found in this product it was thought that it might be due to the fact that the wheat was milled on burrstones and that a part of the ash was in reality insoluble silica due to the wearing away of the stones, but analyses of the ash of these samples for insoluble material or silica showed that only a trace (0.03 to 0.07 per cent) of this substance was present. Thus the only explanation left is that these particular alleged Graham flours having a high ash content in that portion passing through the 109 sieve were made by the use of very poor flour material, a grade even lower than a clear being sometimes used. This is especially true of No. 9109 and may be also true of No. 9241.

TABLE 22.—*Minimum, maximum, and average composition of Graham, alleged Graham, and imitation Graham flours.*

	Graham (observation).				Alleged Graham.[1]				Imitation Graham.			
	Minimum.	Maximum.	Average.	Number of samples.	Minimum.	Maximum.	Average.	Number of samples.	Minimum.	Maximum.	Average.	Number of samples.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*	
Bran	4.0	16.3	7.5	13	0.4	18.8	10.5	28	0	16.2	6.7	39
Shorts	11.5	32.7	18.9	13	4.9	24.0	10.2	28	3.3	37.2	11.7	39
Coarse middlings	5.7	29.6	15.8	13	5.0	19.7	14.6	10	0	24.0	7.5	26
Fine middlings	10.9	24.6	16.0	13	11.1	20.8	16.6	10	0	30.0	10.9	26
Coarse and fine middlings	18.4	48.4	31.8	13	20.5	63.6	40.0	28	0	42.9	16.4	39
Flour	19.2	62.7	41.4	13	23.7	57.9	40.4	28	22.9	86.3	64.6	39
Ash	1.52	1.94	1.74	13	1.54	1.78	1.68	8	.74	2.76	1.56	25
Fiber	1.87	3.42	2.32	13	1.73	2.52	2.05	8	.69	2.47	1.60	9
Pentosans	6.18	7.64	6.77	13	6.35	7.09	6.74	8	3.96	6.85	5.66	11
Nitrogen	1.60	2.34	1.88	13	1.69	2.47	1.98	28	1.71	2.83	2.19	39
Gliadin ratio	36.2	43.1	40.6	13	35.3	42.9	40.5	28	30.7	47.6	40.7	39
Nitrogen of bran	2.15	2.66	2.41	13	2.04	3.03	2.45	28	2.13	4.13	2.62	36
Gliadin ratio of bran	22.6	28.5	25.5	13	18.4	29.8	25.4	28	15.3	33.4	22.2	36
Nitrogen of shorts	2.05	2.66	2.34	13	2.07	2.93	2.46	28	1.95	3.17	2.56	39
Gliadin ratio of shorts	20.0	32.9	24.4	13	19.0	30.3	23.7	28	18.5	38.4	22.9	39
Nitrogen of coarse middlings	1.57	2.48	2.00	13	1.73	2.65	2.05	10	1.70	2.95	2.31	25
Gliadin ratio of coarse middlings	23.4	47.4	36.2	13	20.1	44.6	35.5	10	13.8	53.4	30.8	25
Nitrogen of fine middlings	1.59	2.22	1.80	13	1.66	2.25	1.92	10	1.67	2.72	2.08	24
Gliadin ratio of fine middlings	43.3	52.1	48.4	13	40.2	53.2	45.7	10	21.5	55.0	42.5	24
Nitrogen of coarse and fine middlings	1.58	2.21	1.90	13	1.70	2.50	2.0	28	1.7	2.98	2.34	38
Gliadin ratio of coarse and fine middlings	38.0	49.2	42.3	13	30.8	48.8	39.0	28	16.9	54.5	32.4	38
Nitrogen of flour	1.34	2.43	1.65	13	1.43	2.46	1.75	28	1.4	2.70	2.06	39
Gliadin ratio of flour	47.3	56.8	52.4	13	43.4	58.1	51.0	28	37.8	57.7	50.2	39
Ash of flour	.47	.91	.62	12	.44	.89	.61	10	.39	1.52	.71	26

[1] Samples 9157, 9163, 9211, not included.

GENERAL AVERAGE RESULTS.

A recapitulation of these tables is found in Table 22, which gives the minimum, maximum, and average composition of the Grahams, alleged Grahams, and imitation Grahams. For the purpose of these averages three samples—Nos. 9157, 9163, and 9211—were omitted, it being evident from the separations on the sieves and the amounts of ash, fiber, and pentosans contained in them that they were more of the nature of a "bolted wheat meal" than of a Graham flour. This table shows that the Graham flour contains much more combined bran and shorts, middlings, and much less flour than the imitation samples. The ash, fiber, and pentosans are also appreciably higher in the Graham flour than in imitation Graham. There are no marked differences in the gliadin ratio of the products of separation (bran, shorts, and flour) between the Graham and the imitation Grahams. Still it is seen that the tendency for the Graham is to give higher results in these respects. The gliadin ratios of the coarse and fine middlings of Graham flour are, however, appreciably higher than those of the same products from imitation Graham.

The analytical figures obtained for the alleged Graham flour are generally a mean between those obtained for the Graham and the imitation Graham. Of the 44 samples of Graham or alleged Graham flour only 4 yielded 60 per cent or over of material passing the 109 sieve, the average of all being 40.8. Two of these 4 were, however, shown to be so-called whole-wheat flours and not Grahams. The other 2 samples (Nos. 9103 and 9145) were obtained under observation, but were ground as finely as possible on burrstones. Of the 39 samples of imitation Grahams, 27 gave 60 per cent or over of material fine enough to pass through a 109 sieve, the variation being 61.7 to 86.3, while the average of all the 39 samples was 64.6 per cent. Only 1 out of the 44 samples of Graham gave as low a percentage of middlings as 20, this being No. 9145, which has already been referred to as having been ground very fine and as being high in material passing the 109 sieve. Of the 39 samples of imitation Graham, 25 gave less than 20 per cent middlings. It is almost conclusive proof that the sample is an imitation Graham when it contains only a small amount of middlings. Of the 13 samples of Graham collected under observation, 4 contained less than 20 per cent combined bran and shorts, while 25 out of the 39 samples of imitation Graham showed less than 20 per cent of these materials.

NITROGEN CONTENT AND GLIADIN NUMBER.

Tables 14 to 21 give the ratio percentage between the nitrogen content and gliadin number, respectively, of the Graham flour and those of the products of separation and also between those of the products of separation as compared with one another. Discussion of similar figures in Tables 10 to 12 has already been given, and in the main the points brought out in Tables 14 to 21 agree with those given in the former tables.

COMPARISON OF SAMPLES FROM THE SAME MILLERS AT DIFFERENT TIMES.

Nos. 9047 and 9048 are samples of wheat and Graham flour, respectively, the latter supposed to have been made from the former. Both were obtained from a jobber. The wheat is of a hard spring variety. The flour was so finely ground that it seemed improbable that it could have been produced from such wheat by grinding it on rolls and without separation of the products. The following samples of Graham flour, milled from the same hard spring wheat under observation, were all obtained from a miller who supplied the jobber with the Graham flour No. 9048:

No. 9049 was ground as for the ordinary trade.

No. 9055 was ground as per orders from the jobber just mentioned.

No. 9103 was ground as fine as possible without injuring the product at the request of the representative of the bureau in order to determine whether it was possible that the miller could have furnished the above jobber with his finely ground Graham flour. The separations on the various sieves follow:

Separation of samples specially milled from hard spring wheat.

Product of separation.	Sieve.	No. 9049.	No. 9055.	No. 9103.
		Per cent.	*Per cent.*	*Per cent.*
Bran	On 20 mesh	9.4	7.3	5.0
Shorts	On 40 mesh	16.1	13.4	12.5
Coarse middlings	On 70 mesh	19.1	12.0	7.2
Fine middlings	On 109 mesh	16.6	17.4	14.7
Flour	Through 109 mesh	38.0	49.9	60.6

The following table gives the analysis of the wheat and Graham flour and also of the three samples of Graham flour:

Analysis of samples from one miller at different times.

No.	Sample.	Nitrogen.	Alcohol-soluble nitrogen.	Gliadin ratio.	Ash.	Fiber.
		Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
9047	Wheat	1.95	0.730	37.3	1.95	2.54
9048	Graham flour	1.95	.814	41.7	1.68	2.05
9049	.....do	1.74	.716	41.2	.....	.....
9055	.....do	1.70	.688	40.5	1.74	2.36
9103	.....do	1.72	.709	41.2	.....	.....

The above analyses clearly show that Graham flour No. 9048 could not have been produced from wheat No. 9047 unless a portion of the bran had been bolted. This is evident from the difference in both the percentage of ash and of fiber of the wheat and the flour and the same might be indicated from the difference in the gliadin number. Again, it is manifestly impossible to have made Graham flours Nos. 9049, 9055, and 9103 from wheat No. 9047. The percentages of nitrogen and ash clearly lead one to this conclusion. Inasmuch as these three samples were milled under observation there is no doubt about the impossibility of wheat No. 9047 serving for the three flours. This incident is related here simply to show that the jobber was not getting from the miller the kind of flour he thought he was. It is quite probable that No. 9047 may have been used for the production of No. 9048. In this case No. 9048 was more of the nature of a wheat meal than of a Graham flour, as much of the bran must have been removed in milling.

The following sets of two samples each are from three different millers, the first sample of each series having been collected by the representative of the bureau at one time, while the second sample in each set was collected about six months later.

Analysis of samples from three millers at different times.

Miller and sample No.	Sifted on No. 20 sieve.	Sifted on No. 40 sieve.	Sifted on No. 109 sieve.	Sifted through No. 109 sieve.	Graham flour.		Bran.		Shorts.		Middlings.		Flour.	
					Nitrogen.	Gliadin number.	Nitrogen.	Gliadin number.	Nitrogen.	Gliadin number.	Nitrogen.	Gliadin number.	Nitrogen.	Gliadin number.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*		*P. ct.*	
A {6954	12.5	6.0	39.5	42.0	2.01	41.2	2.63	28.6	2.41	24.4	2.01	27.8	1.81	49.7
A {7795	13.6	10.1	30.3	45.5	2.30	37.8	3.03	28.3	2.98	23.1	2.25	40.6	2.02	47.9
B {6955	13.4	5.5	32.0	46.0	1.90	39.9	2.44	27.1	2.47	20.2	1.88	38.5	1.70	53.5
B {7830	11.8	14.4	32.1	41.4	2.08	37.8	2.61	26.6	2.43	24.2	2.03	40.2	1.81	47.7
C {6956[1]	10.7	7.5	12.5	69.2	2.02	41.7	2.36	24.1	2.27	28.4	2.25	32.8	1.90	49.5
C {7824	9.0	8.4	3.0	78.7	1.80	40.6	2.39	19.5	2.40	20.8	1.90	30.9	1.62	50.2

[1] Based on sample of only 80 grams.

The results are given to show whether the separation and composition of the samples made by the same miller at different times may be expected to be uniform. Nos. 6954 and 7795 from miller A, and Nos. 6955 and 7830 from B, are Graham flour and show no greater differences respectively than might be expected when one considers that Nos. 7795 and 7830 were obtained six months later than Nos. 6954 and 6955 and therefore may have been produced from a different lot of wheat. Nos. 6956 and 7824, from miller C, show the same small differences but are plainly imitation Graham flours.

An interesting incident is connected with sample No. 6956. When the representative first obtained a sample of this flour one member of the firm described it as being "made by grinding whole wheat, removing nothing but about 3 per cent of low grade," intending to indicate thus that it was a Graham flour. The analysis of this first sample led to the suspicion that it was an imitation Graham flour made from very good stock. Another sample was ordered collected, with the request to inquire again how the product was being made. This time another member of the firm stated: "We make the flour by mixing about one-fifth of pure bran and four-fifths of good first-class flour." This incident shows that placing absolute reliance on the statement of the people interested may lead to erroneous interpretations and conclusions. The sample in question was made in the manner indicated by the second member of the firm, namely, one-fifth bran, four-fifths flour, the flour being, however, of very good quality. The fact that the sample previously collected contained but 69.2 per cent of flour passing through the 109 sieve while the second sample contained over 78 per cent would simply indicate that no definite means are taken to measure or weigh the amount of material thus mixed.

The analysis of three samples from the same miller is given in the following table:

Analysis of three samples from the same miller.

Sample No.	On No. 20 sieve, bran.	On No. 40 sieve, shorts.	On No. 70 sieve, coarse middlings.	On No. 109 sieve, fine middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.				
						Nitrogen.	Ash.	Fiber.	Pentosans.	Gliadin ratio.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
9169	7.6	6.6	00	00	85.4	2.32	1.51	.....	.....	47.6
9163	2.3	6.5	8.6	10.6	71.7	2.47	.95	1.11	5.20	47.4
9205	6.5	12.5	8.0	13.5	59.0	1.84	1.69	2.15	6.47	43.1

Sample No.	Bran.		Shorts.		Coarse middlings.		Fine middlings.		Flour.		
	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Ash.
	Per ct.		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*
9169	2.26	20.2	2.37	19.2	.....	.....	.....	.....	2.27	55.9	0.73
9163	2.53	22.5	2.54	22.1	2.19	40.0	2.23	46.9	2.51	53.0	.76
9205	2.39	22.9	2.42	20.2	2.16	30.2	1.85	46.7	1.67	51.7	.67

No. 9169 is an imitation Graham made by adding 70 pounds of bran to 196 pounds of 21 per cent clear flour made from two parts winter wheat and three parts spring wheat.

No. 9163 is a sample supposed to be a Graham and supposed to be made from spring wheat.

No. 9205 was obtained under observation and is made from soft winter wheat ground on French burrs.

There is a notable difference between the three samples. If No. 9169 were really composed of 70 pounds of bran per 196 pounds of flour, the percentage of bran would be over 25, whereas the bran and shorts together amount to 14.2 per cent only. This is clearly not made as indicated by the miller, although it is composed of bran (and shorts) and flour only. The ash content of the flour is what might be expected from such a mixture. No. 9163 was collected from stock on hand and claimed by the miller to be Graham flour. It is, however, materially different from No. 9205, which is also Graham flour. This last sample was collected by the representative who observed the process used in its making. The analyses have already been discussed (see p. 36), but the three samples are placed here together to show that the sample collected by the representative and milled under his observation shows all the qualities of a Graham, while the one whose milling was not thus observed but which the miller claims was Graham flour shows in several respects that it is not what the miller claimed it to be. No. 9163 is high in flour and so low in bran, shorts, ash, fiber, and pentosans that these factors are sufficient to show it to be a "bolted wheat meal" and not Graham flour.

COMPARISON OF SAMPLES OF IMITATION GRAHAM FLOURS.

Analysis of samples of imitation Graham flours.

Sample No.	On No. 20 sieve, bran.	On No. 40 sieve, shorts.	On No. 70 sieve, coarse middlings.	On No. 109 sieve, fine middlings.	Through No. 109 sieve, flour.	Graham flour as per sample.				
						Nitrogen.	Ash.	Fiber.	Pentosans.	Gliadin ratio.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
8017	9.0	14.2	11.6	8.0	57.0	.....	.....	.....	.....	.....
9458	6.2	26.7	11.8	9.5	45.0	2.25	2.08	.....	.....	37.1
9700 [1]	4.6	11.8	6.6	40.0	37.6	2.25	.....	.....	.....	47.1
9705	5.7	16.4	0.2	0.5	76.0	1.91	1.59	.....	.....	44.1
9780	6.2	20.8	7.0	3.8	62.0	2.15	.....	.....	.....	39.9

Sample No.	Bran.		Shorts.		Coarse middlings.		Fine middlings.		Flour.		
	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Ash.
	Per ct.		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*
8017	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9458	2.41	20.9	2.36	32.1	2.21	40.3	2.26	36.6	2.15	41.7	1.36
9700 [1]	.....	.....	.....	.....	.....	.....	1.95	54.9	1.96	54.6	.....
9705	2.42	22.4	2.55	23.4	2.58	.....	1.99	.....	1.80	53.0	.52
9780	2.29	26.4	2.54	21.0	2.86	19.1	2.56	24.5	1.96	49.4	.....

[1] Germ Graham.

No. 8017 gives 57 per cent of material passing through the 109 sieve, and is of good quality. No. 9458 shows a normal amount of products of separation by means of the sieves, but the low quality of the fine middlings and the flour is shown by their low gliadin numbers. The percentage of ash in the flour (1.36) shows also that low-grade flour was used. No. 9700 is sold as a germ Graham. It contains an added quantity of germ. This is seen from a microscopic examination of the bran and shorts. No. 9705 is not Graham. This is evident from the small amount of middlings and the high amount of flour. No. 9780 has also too small an amount of middlings and too large an amount of flour to be considered Graham. Moreover, the gliadin ratio of the coarse and fine middlings is far below what middlings obtained from Graham flour will give.

GENERAL DISCUSSION ON MILLING GRAHAM FLOUR.

Statements made by many millers show that a very large percentage of the so-called Graham flours on the market are mixed products or imitations, not made from purified middlings, bran, and flour, but made from feed bran, which always contains the shorts and the germ, together with low-grade flour, 8 or 10 per cent second clear, and sometimes even red dog, and in many instances such alleged Graham flours contain the sweepings from the mill. When the imitation Graham flours are made by the use of high-grade flour,

purified middlings and bran, it is evident that there is no desire to sell to the consumer a cheap material since the miller believes that the flour thus prepared is a better grade and that better results in baking may be obtained than with the true Graham.

The methods of milling Graham flour are varied. Stone burrs, steel corrugated rolls, attrition mills, and French burrs are used, and usually when the Graham flour was made on steel rolls, anywhere from two to six sets of corrugated rolls were employed, and in some instances, after the wheat had been run through five sets of corrugated rolls, it was then run through six sets of smooth rolls. This is not at all necessary, for good Graham flour can be made on two sets of corrugated rolls or on one set of stones.

WHEAT MEALS, OR IMPROPERLY CALLED WHOLE-WHEAT FLOURS.

In Table 23 are grouped all the samples which resemble bolted wheat meal. Nos. 9133 and 9229 were sold as such, while Nos. 9157, 9163, and 9211 were sold as Grahams. The other samples in the table were stated by the millers to be imitation Grahams. These samples have already been described with the exception of Nos. 9133 and 9229 and the analyses placed in Tables 7–9.

They are grouped here for convenience, in order to compare them with the two samples of improperly called whole-wheat flour, Nos. 9133 and 9229, which are characterized by low bran and shorts contents. Both have, however, considerable amounts of middlings. The ash, fiber, and pentosan contents are low. It is evident that they contain only a very small amount of bran material because the ash is so low and also because the ash of the flour passing through the 109 sieve is but a trifle lower than the ash of the original "wheat meal." The ash of all the other samples varies from 0.79 to 1.36, indicating that the millers make "wheat meal" in a variety of ways. Some millers may make it by removing practically all of the bran; others may remove only the coarse particles, as what remains on the 14 or 20 mesh sieve. The fiber and pentosan contents of the two samples of "wheat meal" are also very low, showing by another means that there is an almost total absence of bran in these samples. The gliadin ratios of the coarse middlings of all the samples, except two, are high. These two (Nos. 7354 and 7746) were made by removing the coarse bran and adding more or less germ bran.

It is evident from the foregoing that it is often necessary not only to make a mechanical separation of the flour and a macroscopic examination of the products, but to determine also the ash, fiber, pentosans, and the nitrogen and gliadin ratios of the products of separation. To know from what kind of wheat the product was produced and whether milled between rolls or burrstones, helps many times to determine with a greater degree of accuracy whether the flour in question is a genuine product or an imitation Graham.

TABLE 23.—*Wheat meals.*

Sample No.	Bran.	Shorts.	Coarse middlings.	Fine middlings.	Flour.	Nitrogen.	Ash.	Fiber.	Pentosans.	Gliadin ratio.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
7354	1.7	8.3	6.3	27.2	55.2	2.45	1.38	.....	.....	45.3
7721	3.7	7.5	12.9	30.0	46.0	2.01	1.20	.....	.....	46.8
7746	5.7	10.9	3.2	3.4	76.8	2.18	1.19	.....	.....	39.3
7764	.0	33.0	22.1	17.4	27.4	2.08	1.47	1.70	5.89	40.9
7803	9.4	12.0	10.3	18.5	49.2	1.97	1.25	.....	.....	38.1
7810	.0	12.7	14.6	25.0	47.1	1.97	1.20	1.32	5.35	42.0
7818	6.1	14.4	15.0	10.5	53.3	1.88	1.29	1.52	5.71	38.1
9085	2.7	37.2	24.0	12.9	22.9	2.23	.74	.84	3.56	45.3
9097	2.3	20.4	16.8	17.4	42.7	1.71	.79	.69	3.96	45.1
9157	7.8	13.2	15.0	7.5	56.2	1.79	1.36	1.49	5.87	46.2
9163	2.3	6.5	8.6	10.6	71.7	2.47	.95	1.11	5.20	47.4
9175	5.3	14.5	4.0	13.4	62.4	2.20	1.37	.....	5.50	43.4
9187	6.7	12.8	7.9	10.3	61.6	1.99	1.46	.....	.....	45.1
9211	3.3	12.5	6.7	7.4	69.4	1.86	1.31	.....	.....	45.3
9229	.0	8.0	20.7	21.8	49.7	1.51	.55	.35	3.07	52.1
9133	.0	.0	2.3	30.5	66.6	2.27	.80	.44	3.35	50.7

Sample No.	Bran.		Shorts.		Coarse middlings.		Fine middlings.		Flour.		
	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Nitrogen.	Gliadin ratio.	Ash.
	Per ct.		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*		*Per ct.*
7354	4.13	19.5	3.05	23.2	2.59	26.0	2.27	42.9	2.45	51.4	0.78
7721	2.41	20.4	2.64	20.5	1.97	43.0	1.87	51.4	2.05	52.7	.65
7746	3.51	18.6	2.93	18.7	2.61	23.9	2.27	39.3	1.97	55.1	.49
7764	.....	.....	2.37	30.2	1.96	42.0	1.91	45.6	1.71	51.3	.50
7803	2.82	19.4	2.69	18.5	2.07	41.7	1.99	45.8	1.77	49.5	.43
7810	.....	.....	2.81	21.5	2.08	35.4	1.83	50.6	1.62	52.8	.47
7818	2.41	22.1	2.28	24.0	1.88	35.6	1.87	42.1	1.71	48.0	.65
9085	2.99	26.5	2.08	38.4	2.08	53.4	2.09	55.0	2.08	57.7	.56
9097	2.60	24.6	1.95	31.6	1.70	44.9	1.71	50.2	1.49	57.0	.39
9157	2.14	28.5	2.00	27.7	1.58	48.4	1.61	52.1	1.73	55.1	.62
9163	2.53	22.5	2.54	22.1	2.19	40.0	2.23	46.9	2.51	53.0	.76
9175	3.42	20.5	2.77	23.1	2.26	33.2	2.05	45.2	1.97	53.0	.57
9187	2.30	29.6	2.54	24.9	1.96	38.0	1.78	50.5	1.88	54.0	.58
9211	2.40	23.7	2.08	25.0	1.93	32.4	1.91	41.9	1.82	53.2	.67
9229	.....	.....	1.74	35.9	1.57	49.2	1.53	55.0	1.38	58.5	.40
9133	.....	.....	.....	.....	2.46	33.7	2.21	48.6	2.39	51.5	.76

LABELING OF GRAHAM FLOUR.

From the beginning of its manufacture Graham flour has been known and understood to be "unbolted wheat meal made from sound, clean, fully matured, air-dried wheat." Investigations herein reported show that many millers adhere to the original manner of preparing Graham flour, but that a large proportion of so-called Graham flours found on the market are simply mixtures of bran and low-grade flour, or bran and second clears, or are made by the abstraction of a portion of the bran or of the best flour in the process of milling; that at times even the bran and the low-grade flour which compose the commercial Graham are not from the same wheat nor from the same variety of wheat, nor are these products necessarily derived from the same locality.

In view of these facts it seems advisable that such mixtures should be called and branded "imitation Graham flour." The "unbolted

wheat meal" should be called "Graham flour" or "whole wheat meal," the latter term being used more or less in England. Furthermore, ground wheat products from which any portion of the bran has been removed, whether the amount so discarded be small or large, should be termed simply "bolted wheat meal." The term "whole wheat" or "entire wheat" flour for a product from which a portion of the bran has been removed is a misnomer and is an inaccurate description of the same. Bolted wheat meal, or what heretofore has been termed "entire wheat" flour, varies in composition according to the amount of bran which has been removed by bolting, but this term could be accurately used for all products intermediate between ordinary flour and Graham or whole-wheat meal. A mixture of low-grade flour and bran, or a whole-wheat meal from which a portion of the bran or of the high-grade flour has been abstracted, should be designated as imitation Graham flour or flour made to simulate Graham flour. Such labeling of wheat products is absolutely essential in order that the consumer may know what he is buying, and furthermore the millers and jobbers should hold to this form of branding in order to maintain the integrity of the trade.

SUMMARY.

Although a large percentage of the so-called Graham flour on the market is made by mixing inferior grades of flour with bran, there are a great many millers who still make Graham flour in the original way, namely, by grinding either on stones or on rolls the whole kernel of the wheat without bolting.

True Graham flour always shows relatively larger amounts of intermediate products, such as coarse and fine middlings of good grade, while imitation Graham generally contains but small amounts of these same products and when these are present in large quantities they are of inferior grade. True Graham contains a larger amount of combined bran and shorts, of combined coarse and fine middlings, and a smaller amount of flour passing through the 109 sieve, than does imitation Graham. The ash, fiber, and pentosans are present in larger amount in true than in imitation Graham. The middlings of the true Graham are of a higher character than those of imitation Graham. This refers to both coarse and fine middlings. The bran of imitation Graham is very often clean and free from adhering endosperm, while the bran of true Graham usually contains a relatively large quantity of such endosperm. This is more or less true also of the shorts.

One does not depend entirely upon the quantity of these intermediate products to determine whether or not a flour is genuine, but one must always determine their quality as well and their relation to each other in appearance and composition, so that it is necessary

to make a macroscopic examination of the products of separation besides the chemical analysis. Out of a total of 83 samples of Graham and imitation Graham flours examined for this bulletin and reported herein it was not difficult to differentiate between these two classes. In examining an imitation Graham flour there was always some point, and, many times, a number of points, which differentiated it from a true Graham and which made it impossible to classify it among the latter.

DEFINITIONS OF MILLING AND CHEMICAL TERMS USED IN THIS BULLETIN.

Ash. Inorganic material remaining after incinerating the sample at a low red heat until all the organic matter is volatilized.

Bran. Chiefly epicarp, endocarp, and embryous membrane, with small amounts of cuticle and adhering endosperm.

Break. Material going to any of the break or corrugated rolls.

Chop. Material which passes through the corrugated rolls and has the flour separated from it. It consists chiefly of endosperm, bran, and germ of irregular angular shapes.

Clear flour. Flour obtained from grinding wheat on corrugated rolls, sometimes known as break flour, and also flour obtained from the tailings of the middlings ground on the smooth rolls.

Cut straight flour. Straight flour from which a portion of the patent has been removed

Fat. Material soluble in ether.

Fiber. Organic material insoluble in 1.25 per cent of boiling sulphuric acid, and 1.25 per cent of boiling sodium hydroxid.

Germ. Embryo of the wheat.

Germ middlings. Embryo adhering to the middlings with small amounts of bran.

Germ scalpings. Residue which is separated from the germ middlings after removing the flour from these.

Germ stock. Used the same as germ middlings.

Gliadin number. Percentage of total nitrogen which is soluble in 70 per cent by volume of alcohol after extraction in the cold for 24 hours.

Middlings. Chiefly endosperm in the shape of irregular angular fragments, more or less free from bran and germ; it is the product from which the best grades of flour are made.

Middlings sizing. Middlings of a more uniform size.

Patent flour. Flour obtained from the reduction of middlings.

Pentosans. Carbohydrates intermediate in food value between starch and fiber.

Red dog. Lowest grade of flour produced in the mills.

Scalp. To remove by sifting.

Shorts. Branny particles, more or less finely ground, containing small amounts of endosperm adhering to them.

Silica-free ash. Ash soluble in dilute hydrochloric acid.

Straight flour. All the flour produced from the wheat except 2 or 3 per cent of the lowest grade.

Tailings. Consist of bran mixed with germ and a considerable amount of middlings, and are the residue remaining after the middlings have been reduced to flour.

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